University of Alberta

Mediated Learning Through the Coaching Approach Facilitated by Cognitive Coaching

By ©

Enid Floretta McLymont

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment
of the requirements for the degree of Doctor of Philosophy

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Abstract

Maximizing students' learning potential in the mathematics classroom has been a major concern for many educators. My concerns about the low national achievement results in mathematics at the exiting high-school level and the dominance of the traditional modes of instruction in the classroom within the Jamaican context led me to conceptualize, introduce, and examine the development of an alternative approach to professional development utilizing the vehicle of cognitive coaching and to explore the generation and use of this approach for the teaching and learning of mathematics.

The research design of this study included an explanatory qualitative methodology that included a multi-embedded case study. The participants included four teachers who sought to translate their professional development experiences into at least one of their mathematics classes. Data collection procedures included conferencing sessions, videotaped semi-structured whole-group interviews with both teachers and students, and students' written reflections. Data were analyzed according to the themes generated and were not confined to those in the conceptual framework.

The major findings include the generation of the *Coaching Approach* through teacher collaboration as a non-judgmental climate for the professional development process. This process was created with the help of the administrative support. The nature of the *Coaching Approach,* with its emphasis on flexibility and universality, facilitated learning by understanding and promoted freedom of expression.

The generation and development of the mathematics learning program (MLP) came about as a result of the utilization of the *tools* for *Cognitive Coaching Discourses* as teachers translated their experiences in the classroom and as their experiences were reproduced and reciprocated among their students to generate collaborative learning. Discourses enhanced collaborative learning that was generated through the mediation of meaning, transcendence, and intentionality and reciprocity as individuals' cognitive structures were modified by these experiences.

Recommendations for theory and practice include the integration of the principles of the *Coaching Approach* in the curriculum of teacher training programs, for the elementary, middle, and high school pedagogical content knowledge areas. Also, stakeholders should be encouraged to participate in the creation of the culture for the development of the program for teaching and learning and encourage their teachers to be involved in cross-school teacher collaboration.

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Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled **Mediated Learning Through the Coaching Approach Facilitated by Cognitive Coaching** submitted by **Enid Floretta McLymont** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy.**

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CHAPTER ONE

INTRODUCTION

> *A teacher of mathematics has a great opportunity. If he* [or she] *fills his* [or her] *allotted time with drilling his* [or her] *students with routine operations he* [or she] *kills their interest, hampers their intellectual development, and misuses his* [or her] *opportunity. But if he* [or she] *challenges the curiosity of his students by setting them problems proportionate to their knowledge, and helps them to solve their problems with stimulating questions, he* [or she] *may give them a taste for, and some means of, independent thinking.* (Polya, 1973, p. v).

Jamaica, a third world nation, is striving to develop its human resources to face the daunting challenges of the twenty-first century. However, the country is faced with a crucial educational problem. The education system fails to prepare and qualify many of the nation's youths upon exiting high school for higher educational pursuits or the work force because they have low pass rates on the exiting external examinations—the Caribbean Examination Council (CXC) examinations (see Table 1). A pass rate in mathematics averaging approximately 25% each year is perceived by the Jamaican populace as a severe disadvantage for the nation. It has also been speculated by several educators that this low pass rate results from the direct teaching methodology that is predominantly practiced by the nation's teachers.

Personally, I believe that a chief contributing factor has also been the judgmental climate perpetuated in the Jamaican classroom. Also, I believe that to develop and prepare critical thinkers and to engage minds in problem solving should be the chief aim of mathematics education, and the contribution resulting from this preparation of critical thinkers is crucial for the development and success of any nation. Therefore, these concerns about low mathematics achievement at the high-school level led me to contemplate conceptualizing an approach for professional development for the teachers of mathematics at this level that would help teachers move away from the traditional mode of instruction (direct teaching), overcome the cultivation of judgments, and move toward more promising student-centered practices.

This chapter provides a background to the proposed setting, the nature of professional development in the Jamaican context, and the need for student-centered classrooms. A brief outline of the study and its purpose, the research questions, the significance of the study, the terminology used, and the overall organization of the dissertation, are also included.

The following table shows the national results of the Caribbean Examination Council examinations from 1992 to 1997. The number of examinees who sat and those who passed the examinations (CXC, 1992; 1994; 1995; 1996; 1997; Education Statistics, 1995).

Table 1

National CXC Results for Mathematics (Jamaica)

Year	***1992***	***1993***	***1994***	***1995***	***1996***	***1997***
No. of Examinees	***12 388***	***13 768***	***14 654***	***14 909***	***15 023***	***16 178***
No. Passed	***3 446***	***3 435***	***3458***	***4 170***	***3 642***	***3 302***
% Passed	***27.82%***	***24.9%***	***23.6%***	***27.97%***	***24.24%***	***20.41%***

Professional Development in the Jamaican Context

Professional development for high school mathematics teachers in Jamaica exists at a minimal level. The general practice for professional development has always been one in which "experts" are "brought in" to "pass on" new information and techniques to teachers. These experts have sought to improve the situation by implementing projects or by conducting professional development training sessions to bring about change. However, these experts from international and local organizations have usually employed a fidelity approach to professional development (Snyder, Bolin, & Zumwalt, 1992). This approach consists of pre-packaged objectives and content and a prescribed way of how delivery is to be carried out. The package for professional development is generally delivered to teachers in a traditional mode of instruction and is generally done through funded projects. However, after the time allotted for the projects have expired, from my experience and that of many other Jamaican teachers, few changes have been sustained in the lived everyday practices in the classrooms.

The Need For a Collaborative Approach to Professional Development

Projects embracing the fidelity approach to implementation seemed to lend themselves to limited teacher growth in Jamaica. It is therefore imperative that the "voices" and needs of teachers be accommodated in a more fluid and dynamic model (Spencer, 1996) so that professional development can be effective. When professional development is situated in the richness of classroom experiences rather than in abstract conceptualization, it will be more effective (Barth, 1996). It will also be successful if a symbiotic process of teacher growth and student growth happen together, one enhancing the other (Joyce & Showers, 1995). When teachers and their students are encouraged to jointly create an educational experience for mathematics learning, this experience will not be viewed as an externally imposed instructional program in which teaching strategies and materials have been prescribed. Rather, teachers will empower themselves to create an instructional process utilizing the knowledge and the strategies they have embraced.

It is also my feeling that the similarity between teacher practices and student-learner practices, wherein each in his or her sphere or "confined space" had been working as a loner, must change. The "closed doors" of the private world of teachers' teaching and learning space need to disappear to allow their peers entry so that teacher thinking will be enhanced and the teaching and learning situation revolutionized. One process, I envisioned for the removal of these doors, is professional development through collaborative learning (Bruffee, 1993, 1995) utilizing the vehicle of cognitive coaching (Costa & Garmston, 1994). Professional development is a channel for providing teachers with the occasion to tailor knowledge and beliefs about content and pedagogical practices to improve teaching and learning and caring for children (Sparks & Hirsh, 1997; Caruso & Fawcett, 1999). Collaborative learning, on the other hand, is a social learning context that allows learners to cultivate and develop the "craft of interdependence" (Bruffee, 1995, p. 1) and to construct knowledge as a result of the social process involved in this mode of inquiry (Bruffee, 1993, 1995).

As teachers' levels of consciousness are raised through collaboration with peers (da Costa, 1993, 1995; Hargreaves & Dawe, 1990; Joyce & Showers, 1982; 1995) within the same subject area, it is hoped that many barriers to growth can be overcome. "Subject-specific" teacher collaboration (Little, 1993), is an alternative paradigm of professional development to the usual practice in which teachers of various subject areas are brought together within the same setting. This collaboration, according to Little, encompasses teachers' knowledge of academic content, modes for instruction, and student learning. Collaboration will equip teachers individually and as a group and add more depth and breadth to their knowledge of subject matter. It will also aid teachers to assume more assertive roles in reforming curriculum, assessment practices, and pedagogical approaches (Little, 1993). I believe that an effective professional development for teachers of mathematics should include a collaborative model that recognizes the expertise and personal histories of the participants and also provides an opportunity to bring forth a new setting for teaching and learning. I feel that the utilization of *cognitive coaching* (Costa & Garmston, 1994) as a "vehicle" would promote this form of professional development that would in turn tap students' mental resources in the classroom. *Cognitive coaching* is a clinical supervision model that engages, develops, and enhances the intellectual processes (Costa & Garmston, 1994) as teachers engage each other in coaching conference cycles to generate interactive discourses (Gee, 1996; Hicks, 1995; NCTM, 1991).

The Need To Tap Students' Mental Resources

I believe that the traditional mode of instruction utilized in the teaching-learning context does not "tap" students' mental resources. The traditional mode of instruction encourages sitting alone and working in silence (Silver & Smith, 1996), pondering formulas (Silver, 1996), and algorithms. Also, this direct teaching method encourages teachers to verbalize the mathematical concepts they understand, thus reinforcing their own knowledge while trying to transmit these concepts to students. Hence, this method of teaching promote the passive role of sitting and listening (Campione, Brown, & Connell, 1988). Utilizing this method, teachers may allow students' minimal participation by soliciting short answers to their questions which are designed to enhance the flow of their explanations (TIMSS, 1996). Students are expected to memorize information and regurgitate it upon request (Fisher, 1998); thus, this mode of teaching and learning tended towards encapsulated and inert knowledge and skills (Campione et al., 1988) as students are not able to readily make desired and needful connections between and among mathematics concepts and principles.

I believe that students should therefore engage in a collaborative setting with activities that enable them to explore, conjecture, reason logically (NCTM, 1991), and to connect ideas within and between topic areas of mathematics and other intellectual activities. As students collaborate, greater levels of rapport through team work will be developed to enhance their communication skills and construction of knowledge. Students will also become more confident in their mathematical ability while being engaged physically and intellectually in mathematical tasks in a caring environment (NCTM, 1989).

Through collaboration, the traditional classroom setting and climate can change, and trust among and between students and teachers will play a fundamental role. In this collaborative classroom setting, teachers, as well as students, will respect the ideas of others. This collaborative setting will promote more meaningful cognitive and metacognitive activities; students will experience elaborations in their thinking as they share (Foreman, 1995), and they will—most importantly—be able to construct their own knowledge.

The Purpose of the Study

This study has emerged from my concerns about the low national achievement in mathematics at the exiting high school level and the dominance of the traditional mode of instruction in the classroom within the Jamaican context. Also, I am concerned that programs designed outside of the context in which they are to be implemented are generally short-lived and seldom become part of the everyday experiences of the classroom. These concerns have led me to contemplate the development of an alternative approach to direct teaching for professional development of high school mathematics teachers in Jamaica in order to generate an alternative approach to the direct teaching method for the teaching and learning of mathematics—the *mathematics learning* *experiences* (MLE)—to tap the mental resources of all students in the classroom. The dominant practice—direct teaching—for mathematics teaching has been one that can only be classified as traditional.

My study takes the form of a qualitative research approach which includes multiple research techniques and multiple modes of data collection. It involved teachers and students in a collaborative project—The Mathematics Learning Project (MLP)—over a period of six months. The professional development that teachers were invited to participate in is termed the Professional Development Process (PDP). The initial professional development (Phase I) was a five-day seminar series. This five-day seminar series was divided into three consecutive days in June 1997 and two consecutive days in September 1997. As participant- researcher, I invited teachers to participate in the seminars in a collaborative setting focusing on their experiences utilizing the *tools* embedded in *cognitive coaching*. Phase II consisted of the continuation of the teachers' professional development experiences, the teachers' translation of their seminar experiences into their mathematics classrooms, along with the students' engagement in the *mathematics learning experiences* (MLE) from September to December, 1997.

The purpose of my study was to conceptualize, introduce, and examine the development of an alternative approach for professional development for high-school mathematics teachers, and to explore the generation and accommodation of this alternative approach for the teaching and learning of mathematics—the Mathematics Learning Program (MLP). The purpose was also to generate an approach to tap the mental resources of all students in the mathematics classroom and to offer every student the opportunity to develop their mathematical power—the *mathematics learning experiences* (MLE). I chose to use the *tools* of *cognitive coaching* as the vehicle for the Professional Development Process (PDP).

As the "flame" of teachers' and students' cognition was kindled to allow this experience to come about, I sought to document the processes, experiences, and factors relating to these experiences. It is hoped that the results of this study will serve to address the problem that is facing the nation's teaching and learning of mathematics at a micro level.

Research Questions

This study was guided by and served to address the following research questions:

1. *How was the Professional Development Process (PDP) utilizing the vehicle of cognitive coaching perceived and accommodated by teachers of mathematics in the Jamaican context?*
2. *What were the teachers' and students' perceptions of the generation and development of the Mathematics Learning Program (MLP)?*

Significance of The Study

I believe this study is significant to students, teachers, administrators, college and university educators, and policy makers not only in Jamaica but also other developing and developed countries because:

1. The use of the *tools* embedded in *cognitive coaching* may help teachers to become more accommodating of peer input and may lead to improve the teaching and learning of mathematics.
2. The classroom milieu developed during the students' accommodation of the *mathematics learning experiences* might help teachers become more aware of the impact of interdependence on students' performance; hence, teachers might give more consideration to the social context for learning.
3. The collaboration that developed during the Professional Development Process (PDP) for teachers and the *mathematics learning experiences* (MLE) for students might enhance teaching and learning. If so, teachers through peer collaboration can share their ideas of how this has worked for them. Also, teacher educators and administrators, through professional development programs, might also recognize and promote the importance of peer collaboration among teachers and students to enhance growth.
4. To my knowledge, there have been no studies utilizing *cognitive coaching* for the development of alternative ways of teaching mathematics at the high-school level nationally or internationally. Documenting the experiences of this study will add a

new dimension to the body of knowledge that exists on *cognitive coaching* and alternative approaches for the teaching and learning of mathematics.

5. If *cognitive coaching* impacts mathematics learning, teachers of other subjects might want to consider using it in the teaching and learning of their subjects.
6. This approach highlights the importance of administrators' roles in promoting a collaborative culture in their schools.

Terminology

Coaching Discourse (a coined term) is the reciprocal utilization of the system of verbal and non-verbal *trust building tools* of *cognitive coaching* for the enhancement of communication and understanding and the exploration of ideas, beliefs, and values in a collaborative setting.

"Cognitive Coaching is a non-judgmental process built around a planning conference, observation, and a reflecting conference." It is a coaching relationship that "may be established between teachers and teachers, administrators and teachers, and/or administrators and fellow administrators" (Costa & Garmston, 1994, p. 2).

Collaboration is an interactive process that occurs between individuals of similar status while working jointly rather than individually on the same task or on separate components. This results in negotiation, mutual discovery, reciprocal feedback, and frequent sharing of ideas (Damon & Phelps, 1989; Dillenbourg, 1999).

Reflective Coaching Discourse (a coined term) is the verbal and non-verbal interactive communicative networking generated as a result of thinking about or reflecting on the ideas, values, and beliefs that were generated during the *Coaching Discourses*.

Tools are methods used in performing an operation or are necessary in the practice of a vocation or profession (Merriam-Webster's Collegiate Dictionary, 10th ed.).

Translation is the process of synthesizing information in the context of what one knows and understands and reshaping and reorganizing it to devolve in a communicable manner. The dual process of assimilation and accommodation is subsumed.

Organization of Dissertation

This dissertation is organized into seven chapters. Chapter One provides an orientation to the problem studied. Chapter Two presents the review of the literature and the conceptual framework that provides the various concepts that served as the lenses through which this research was conceived, executed, and to some extent interpreted. Chapter Three, the method, frames the data gathering process. Through this frame, the data gathered were viewed and analyzed within the boundaries of limitations, delimitations, trustworthiness, validity and ethical considerations. Chapters Four, Five, and Six present an analysis of the data after returning from the field. In Chapter Four, the mode of analysis provides an overview of the teachers' reflections on the generation of the new approach to teaching and learning, the *Coaching Approach*. Chapter Five explores the *tools* for cognition in the *Coaching Approach* employed by the teachers as they translated their experiences during the Professional Development Process (PDP) to bring about the *mathematics learning experiences* (MLE) for their students. The case of one teacher and her classes is also included. Chapter Six explores more deeply the coaching experience with the other three teachers and their classes—the case of the other three teachers. This chapter also provides a reflection on aspects of the teachers' experiences and a description of the growth of the students' *mathematics learning experiences* to the point where one can probably begin to perceive these as sustainable practices.

Chapter Seven presents the principles, relationships, and generalizations deduced; and the discussion of the findings in light of the literature. The shared thinking, differences, and similarities in the educators' and researchers' perspectives on issues that emerged from the data analysis are addressed. The set of findings not addressed by the literature is also included. Chapter Seven also offers the conclusions and recommendations that emerged from my findings for learning and practice in the educational arena.

CHAPTER TWO[1]

REVIEW OF THE LITERATURE

> *Probably nothing within a school has more impact on children, in terms of skills development, self-confidence, and classroom behavior, than the personal and professional growth of teachers. When teachers individually and collectively examine, question, reflect on their ideals, and develop new practices that lead toward those ideals, the school and its inhabitants are alive. When teachers stop growing, so do their students.* (Barth, 1996, p. 147)

Conceptualizing this study to generate an alternate approach to the traditional mode of instruction for the teaching and learning of mathematics (direct teaching), I examined the literature to identify attributes of my conception and to provide elaborations of and enhancement to the concepts and principles envisioned in the alternate approach. This chapter, therefore, presents a review of the literature relating to concepts and principles embedded in this study. It explores the literature on professional development, the involvement of the educational hierarchy to effect the process of change, teacher collaboration that embraces reflection and mediational discourses, and cognitive coaching facilitated by trust through its *tools*. It also reviews the literature on alternatives to traditional instruction, including grouping for instruction in different forms, discourse, reciprocal teaching, and the role of the teacher in the discourse-oriented classroom. A graphical representation of the conceptual framework is also included. The conceptual framework suggests a proposed parallel between the teachers' professional development process (PDP) and the students' *mathematics learning experiences* (MLE) in the collaborative classroom setting and suggests that there is a reciprocal relationship between the two components.

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a. A version of this chapter has been prepared as part of a paper presented at the April 1998 American Educational Research Association Annual Meeting, San Diego, California, U.S.A., and has been published. Mclymont, E.F. & da Costa, J. L. (1998). ERIC Document Reproduction Service ED 420 637

b. A version of this chapter has been prepared as part of a paper presented at the 1998 International Multicultural Conference University of Alberta, Canada, and has been published. McLymont, E. F. (1998). International multiculturalism 1998: Preparing together for the 21st century, pp. 236 - 250.

c. A version of this chapter has been prepared as part of a paper presented at the 3rd African Society Conference 2000: Prospects for an African Renaissance. University of Alberta, Edmonton, Canada. February 2000.

Professional Development

Professional development, Sparks and Hirsh (1997) maintained, means providing teachers with the occasion to reflect and shape new knowledge and beliefs about content, pedagogy, and the way their students learn. The experiences provided during these occasions for developing knowledge, skills, and the attitudes needed to improve teaching and caring for children, according to Caruso and Fawcett (1999), are another dimension of professional development that is growth-oriented. This growth-oriented conception is designed to foster practitioners' personal and professional development. Professional development, to Lambert (1989), means developing the profession as well as oneself when teachers as learners are empowered and engaged in reflective practice, collegiality, and shared responsibility and when their roles are changed from one that is passive to one that is active. Therefore, to bring about professional development that is growth-oriented, an approach which does not encourage resistance to change but which is fluid and dynamic and recognizes the complexities of the classroom, gives voice to teachers, and encourages teachers' growth for students' growth in a collegial collaborative setting, is needed.

Professional development programs are most often designed for teachers to adapt or adopt a pre-designed curriculum, new program, or innovation to be implemented (Hargreaves & Dawe, 1990). According to Little (1993), the underlying assumptions of the dominant training model for teachers' professional development focus mainly on increasing their skills and techniques for class use. However, this model "is not adequate to the ambitious visions of teaching and schooling embedded in present reform initiatives" (Little, p. 129) because it is almost always prepackaged and imposed on teachers from external sources. Lambert (1989) claimed that the most dominant model for professional development—the training model—is in many ways parallel to the direct instruction model for students. When this dominant training model has been utilized, reformers from without and within have often met with resistance to change. Resistance, according to Fullan and Miles (1992), is generally interpreted as "intransigence, entrenchment, fearfulness, reluctance to buy in, complacency, unwillingness to alter behaviors, and failure to recognize the need for change" (p. 478). This label, according to Fullan and Miles, categorizes everything as "attitude" and diverts attention away from the real issues of lack of certain skills and other needed resources for the needed change. Changes involve both attitudes and behaviors and need to be "framed as natural responses to transition" (Fullan & Miles, 1992, p. 748). Time, as a resource, is also considered a crucial element that contributes to resistance to change (Fullan & Miles; Greene, 1992).

By seeking teachers' input in planning and by ensuring that the program that has been pre-designed is aligned to teachers' needs, staff developers, according to Guskey (1985), seek to avoid resistance and try to gain teachers' acceptance and commitment prior to the implementation of the new program or innovation. But these activities, Guskey stated, seldom lead to significant changes in teachers' beliefs or elicit strong commitment from them. He suggested that "only when teachers see that a new program or innovation enhances the learning outcomes of their students, then, and perhaps only then, is significant change in their beliefs and attitudes likely to occur" (Guskey, p. 58). Greene (1992), reporting on a successful professional development model which took place in the Medicine Hat School District of southern Alberta, Canada, stated that even though teachers were invited to participate in the early stages of this three-year project and made up 50% of the population of the participants, they nevertheless "believed that this project was being imposed on them and that they were participating in a different capacity than were administrators" (p.135). Hence, for teachers to change their beliefs or their teaching practices, Green (1992) posited that they must believe in the professional development process even though their busy schedules and heavy teaching loads impact the level of implementation of the professional development model.

According to Barth (1996), change imposed upon schools from without does not work; at best, it may promote a momentary compliance that "vanishes with the departure of the change agent" (p. 146). Often, according to Spencer (1996), "teachers have been expected to accept and introduce blueprints for change, regardless of whether they might be workable in their own school context. This static model for change" does not consider teachers' needs and does "not serve as a viable framework for understanding the conditions under which teachers can and do change their teaching practices" (Spencer, 1996, p. 17). Showers, Joyce, and Bennett (1987) also stated that "teachers bring to professional development their knowledge and skills, their learning and teaching styles, their personal characteristics," and their "perceptions about their needs and preferences for certain kinds of staff development" (p. 79). Therefore, to address the need for an effective professional development program, a new approach that re-examines the process of teacher change as a gradual process; that provides teachers with regular feedback about student learning; that provides continued and follow-up support (Guskey, 1985); that includes opportunities for teachers to inquire and reflect upon practice, elicit and share knowledge, and work collaboratively (Lambert, 1989); and that offers continuous and on-going professional development (Lewis, 1997; Darling-Harmmond in Reforming the Teaching Profession, 1997)—is needed.

It is therefore imperative that teachers be exposed to "a more fluid and dynamic model" which would recognize the complexities of the classroom interaction and would allow for diversity and variability so that "teachers' multiple voices" can be heard (Spencer, 1996, p. 17). Emerging alternatives to the training model, according to Little (1993), embody assumptions about teaching and learning that are perceived as a "revolutionary insight." This revolutionary insight, Lambert (1989) asserted, "coincided with an increased knowledge about adult learning" that made it clear that one's "cognitive complexity continues to develop or has the potential to do so throughout one's life, even into late adulthood" (Lambert, p. 78). This process of having teachers experience firsthand what their students will experience in the classroom is also emphasized by the SPELT program developed by Mulcahy (1991). The process also provides teachers with the ongoing opportunity to express their concerns. This, Mulcahy maintained, is a key factor in facilitating teachers' receptivity to change. To have teachers actively engaged as learners, Mulcahy emphasized, is a demonstration to them that they should continue to develop their thinking skills. With this consideration, teachers can have a more positive exposure to professional development in which growth is emphasized. Such professional development is less likely to meet with resistance.

Growth, experienced by teachers as they are actively engaged as learners, reflects the teaching methods which they might want to employ, so that their students will have a similar learning experience to theirs (Sparks & Hirsh, 1997). Hence, when professional development is a dynamic process of learning, it leads to learning by understanding instead of acquiring new factual knowledge (Duke, 1990). It will serve to equip teachers individually and collectively and to engage them in multiple challenges "in subject matter standards, curriculum content, assessment, and pedagogy that increasingly aspire to more ambitious student outcomes" (Little, 1993, p. 130).

Fullan and Miles (1992) maintained that change is a learning process, and individuals develop a sense of ownership and personal meaning only through the learning process as they come to understand and be good at something over time. Guskey (1985) reinforced these beliefs by stating that professional development which focuses on changes in student learning outcomes is targeted as an alternative approach for effective professional development. "Learning outcomes," he stated, "include not only cognitive and achievement indexes, but a wide range of student affective variables, such as involvement in class sessions; motivation for learning; and student attitudes toward school, the class, and themselves" (Guskey, p. 58).

Guskey (1985) asserted that any evidence a teacher can use to judge the effectiveness of his or her teaching can be termed a learning outcome. Therefore, when teachers observe that the learning outcomes of their students are enhanced by a new program, perhaps only then will changes in their beliefs occur. Also, for professional development to be effective, the new practices involved in innovations should not involve too much disruption or extra work (Guskey). Everything done in the professional development setting should begin with a focus on high expectations for all students and should provide opportunities for optimum success in student learning (Sparks & Hirsh, 1997).

Little (1993) stated that few school reforms specifically target structures of students' opportunity to learn. "Subject-specific teacher collaboratives" (p. 134) have been viewed as an alternative paradigm of professional development. According to Little (1993), the idea is to promote and provoke breakthroughs in conceptual understanding for teachers by facilitating experiences rather than by providing content or methods. The former, Little strongly felt, will provide “an alternative to the shallow, fragmented content and passive teacher roles” (p., 138) which are observed in dominant training models.

Spencer (1996) acknowledged that a growing body of research has shown that “teachers are not passive consumers of innovations” (p.16) but use innovations when they can be adapted to meet the needs of their students in the teaching-learning context. Therefore, school leaders, according to Costa and Garmston (1994), have to realize that for teachers to grow professionally and effect innovations, they need to seek collegiality. Because of teacher isolation (Hargreaves & Dawe, 1990), collegial relationships with their peers might be uncomfortable at first. However, Showers (1990) hypothesized that when opportunities for substantive collegial interaction (coaching) are provided, they help teachers to integrate thoughtfully the use of new knowledge, behaviors, and materials and add them to their existing repertoires. Also, these interactions help to provide teachers with collaborative relationships and support, as teachers strive to embrace new programs or innovations (Showers).

Everything that impacts teachers has a potential to lead to personal and professional growth (Barth, 1996). Barth explained that teachers experience professional growth when they begin to examine and question their teaching practices as well as those of others; when they become interested when someone has an exciting new idea for exploration. Barth emphasized that isolated teachers must be provided with occasions, means, and opportunities to coalesce and explore joint ventures, with feelings of suspicion and competition left behind. Professional development, Darling-Harmmond (1997) emphasized, should therefore take place within a team, network, or community of professionals.

Involvement of the Educational Hierarchy to Effect the Process of Change

Regardless of whether an innovation originated with “teachers, building administrators, or a school system,” according to Showers, Joyce, and Bennett (1987), “shared understandings fuel and sustain innovations” (p. 80). Fullan and Miles (1992) also argued that when a school district is closely involved with a school in a supportive, collaborative manner, successful change will most likely be effected. From the moment of inception of any program, Fullan and Miles emphasized that power must be devolved to those who will be involved in the realization of the learning process. Greene (1992) maintained that it is essential to have teachers and administrators at the local school site participating from the initial stages in the implementation of professional development programs. However, although teachers' commitment and involvement were crucial to the Medicine Hat professional development project's success, "district commitment and support were equally critical" (p.137). Although the project was initially conceived by teachers and administrators, "the model was implemented by the central office personnel who provided the training, the resources, the incentives, and the expectation of participation" (Greene, p. 137).

Fullan and Miles (1992) noted that "change is systemic" and should focus simultaneously on the development and interrelationships of all the main components of the system. As well, focus should be placed "on deeper issues of the culture of the system" (p. 751). Hodges (1996) also recommended that professional development should involve ongoing administrative and cultural support that focuses on norms of collegiality. Glickman, Gordon, and Ross-Gordon (1995) reinforced this by stating that "successful educational improvement is most often a result of simultaneous bottom-up and top-down initiatives that converge into a clear, moral center" (p. 435). Therefore, "those who live and work in the schools almost certainly have better ideas of needs and opportunities there" and as a result "should be free to make the decisions for that school" (p. 441). Consequently, everyone—principals, department heads, teachers, counselors, and parents in the school community—should be included in creating a shared purpose (Fullan & Miles, 1992; Lewis, 1997). When local educators are excluded from "the decisions that they are expected to carry out, we rob them of the process of learning and the opportunity to develop commitment to the change" (Glickman et al., 1995, p. 441). Joyce and Showers (1995) found that when faculty groups or representative of school districts enter a program together, higher rates of transfer of programs are achieved.

For high rates of implementation to occur, principals' support is integral (Joyce & Showers, 1995). Lewis (1997) also reinforced this by referring to Darling-Harmmond and McLaughin's recommendations that school structures be redesigned to allow for teacher collaboration and learning when serious attention is being given to practice. There should also be a rethinking of "schedules and staffing patterns to create blocks of time for teachers to plan and work together" (Lewis, p. 15). Creating time for professional development, according to Greene (1992), is "both a pragmatic, concrete, solvable problem and a measure of support for . . . change" (p. 138). Fullan & Miles (1992) endorsed this view, stating that "only when extra requirements of change are met through the provision of released time or through a redesign of the schedule" is success likely (p. 750). Darling-Harmmond (1997) suggested that creating opportunities for teachers to serve as critical friends for one another could also be facilitated by rethinking staffing and schedules. Furthermore, she suggested that principals and vice principals could substitute for teachers to allow for the process of collaboration.

Joyce and Showers (1995) found that when principals took active roles helping to form teams, supporting teachers, providing times in meetings for the sharing of teaching and planning, and providing help, coaching flourished. As well, principals observed and encouraged teachers as they tried the new strategies. They provided varying amounts of pressure and support for the practice of new strategies, often borrowing classes to practice the strategies themselves (Joyce & Showers). The provision of this support, according to Fullan and Miles (1992), may be the only way change happens; that is, when implementation is done locally by "everyday teachers, principals, . . . and students" (p. 752).

"Principals are gate keepers of improvement in schools" (Wood, Killian, McQuarrie, & Thompson as cited in Hodges, 1996, p. 231). Their level of involvement is important to the success of any professional development effort designed to improve school practices (Hodges) because initiatives that engender change cannot run by themselves—change requires power—and therefore keeping administrators informed will aid in eliciting their support and involvement (Fullan & Miles, 1992). The power and attraction of professional development, according to Lambert (1989), lies in the opportunity to talk to other teachers, which can only be brought about through teacher collaboration.

Teacher Collaboration

The persistent failure to secure curriculum implementation and planned educational change at the classroom level and the professional isolation of the classroom teacher have served to stimulate a growing interest in bringing about a professional culture of teaching that is more conducive to change (Hargreaves & Dawe, 1990). Classroom isolation, according to Hargreaves and Dawe, is responsible for the anxiety teachers experience about their effectiveness, their fear of being evaluated, and their immersion in their own classrooms. Furthermore, it is also felt that teacher isolation contributes to teachers' reluctance to explore and embrace alternative teaching approaches that may challenge their expertise. Liberating teachers from their isolation and thereby "cracking the walls of privatism," is recognized by Hargreaves and Dawe (p. 227) as an important move to promote collaborative forms of professional development and an essential means to secure lasting educational change. Therefore, the role of collegiality and collaboration, including cognitive coaching that fosters better working relations and offers essential support for teachers to improve their instructional effectiveness, are considered.

Collegiality among teachers, according to Sergiovanni (1991), is an important ingredient to foster better working relations and conditions, to improve teaching practice, and to acquire better results. This idea is being translated into various means of getting teachers to work together, to share their experiences, and to help one another (Sergiovanni). However, the anticipated results of these efforts have not materialized. Too often, Sergiovanni noted, the collegiality is contrived and not real, or it is interpreted as congeniality; however, the distinction needs to be made: "Congeniality refers to the friendly human relationships that exist in a school, which are characterized by loyalty, trust, and easy conversation among faculty" while "contrived collegiality is administratively imposed or organizationally induced" (Sergiovanni, p. 212-213). Greene (1992) found that contrived collegiality was often less effective, either because shared interest did not exist between partners or because one partner did not have the expertise that the other expected. Sergiovanni (1991) maintained, however, that even though contrived collegiality is not the same as the real thing, it is better than none.

Many researchers (e.g., da Costa, 1993, 1995; Ellis, 1990; Garmston, Linder, & Whitaker, 1993; Guskey 1985; Hargreaves & Dawe, 1990; Joyce & Showers, 1982, 1995; Little, 1993; Showers, 1985, 1990) have recognized that collaboration among teachers is an essential element for professional practice. For teachers to develop and grow professionally, da Costa (1993) suggested that teachers should be brought together in collaborative working relationships that engender teacher-teacher interactions. This development of a professional culture of teaching or collaborative forms of professional development within and among schools is considered a more responsive and receptive lever for change and has become a priority in many schools (Hargreaves & Dawe, 1990). Also, according to Wren and Harris-Schmidt (1991), because there has been a shift to collaborative learning in both the elementary and secondary schools and because many teachers and professors have little or no direct experience with collaborative learning methods, a call is being made for reform in college and university circles to replace the traditional concept of teaching with the new concept of collaborative learning.

Collaboration, according to Wren and Harris-Schmidt (1991), is a broad term used to describe "any number of administrative, faculty, or student groups working together, including faculty doing team teaching or cross-disciplinary research, joint faculty-student inquiry both in and out of class, and students studying together or completing group projects" (p. 263). Collaboration, as Glickman et al. (1995) defined it, is working jointly with others in an intellectual endeavor and is premised on participation by equals in instructional decisions. Collaboration, they stated, appears to be a democratic way of doing things, and its outcome is a mutual plan of action. Glickman et al. identified the behaviors inherent in collaboration as clarifying, listening, reflecting, presenting, problem-solving, and negotiating. Kain (1996) in his study, in which teachers collaborated on the controversial issue of grading practices, found that collaboration became an opportunity for problem solving as teachers pooled their ideas on grading. Grading was initially viewed as "typically completely private and mysterious" (p. 584). He also found that, as teachers collaborated, they "opened up their own practices to scrutiny, offering possibility of growth" (Kain, p. 584).

Collaboration has been recognized as a strategy for bringing about successful educational reform if it provides a "workable professional environment that fosters learning" and provides enough time for teachers to "reflect, plan, and discuss teaching innovations and problems with colleagues" (Ellis, 1990, p. 267). It is also considered "a tool for teacher empowerment and professional enhancement, bringing colleagues and their expertise together to generate critical yet also practically grounded reflection on what they do as a basis for wiser more skilled action," and not "to facilitate the smooth and uncritical adoption of preferred forms of action (new teaching styles) introduced and imposed by experts from elsewhere, in which teachers become technicians rather than professionals" (Hargreaves & Dawe, 1990, p.230).

In the supervision model, Glickman et al. (1995) advised that collaboration is appropriate when similar levels of expertise, involvement, and concern are shared by teachers and supervisors with a problem. However, they noted that an important consideration for supervisors "is the fact that collaboration is both an attitude and a repertoire of behaviors," and "unless teachers have the attitude that they are equal, collaborative behaviors can be used to undermine true equality" (p. 167). The "benefits of the collaboration approach to teacher supervision include cooperation and communication, nurturance of teacher self-confidence, reduction in teacher anxiety, and a facilitation of change in teacher behavior" (Goldhammer, Anderson, & Krajewski, 1993, p. 62).

The process involved in collaborative consultation, da Costa (1995) asserted, is a relationship between teacher dyads that is nonhierarchical, is predicated on mutual trust and respect and is "presumed to provide a supportive environment" in which the teacher can implement and evaluate new teaching strategies (da Costa, p. 418). This learning environment created by teacher collaboration encourages flexibility in roles to meet the needs of others. Teachers are able to redefine their roles, reflect on their own competence, converse with peers, participate in decisions, and thereby elicit and articulate their own knowledge (Lambert, 1989).

Collaboration can take varying forms such as collegial consultation, collaborative consultation, and coaching. Coaching, according to Joyce and Showers (1995), has been used in multiple contexts in the past. They observed that *technical coaching, collegial coaching, challenge coaching* (Hargreaves & Dawe, 1990), *team coaching, cognitive coaching,* and *peer coaching* should not be confused with evaluation. Showers (1985) advocated that, in coaching, teachers should work together in teams to study instruction; and where their relationship is balanced, coaching and supervision are compatible.

Also, collaboration can take the form of clinical supervision. Goldhammer et al. (1993) suggested that supervisors in collaborative roles as coaches should participate with teachers in setting goals to promote teacher self-evaluation. They noted that a conscious building of rapport facilitates this condition, and with trust established further observation and discussions will serve to enhance the collaborative relationship (Goldhammer et al.). This mode of collaboration should be formative only, because the job of the coach is not to identify what is "wrong" or "right" with the teacher's teaching, but rather to help the teacher identify areas for improvement. Joyce and Showers (1995) emphasized that "formative evaluation is a critical element that maintains focus, linking a vision of what schooling can be for students and the progress toward that vision" (p. 143).

However, the evaluative component of supervision, according to Joyce and Showers (1988), prevents the very climate essential for learning—experimentation, permission to fail, revision, and repeated trials while continuously practicing new skills and procedures. Hargreaves and Dawe (1990) stated that the hierarchical relations embedded in bureaucratically driven systems serve as barriers to the development of a collaborative culture which is trusting, sharing, and reflective. Hargreaves and Dawe maintained that "supervision is incompatible with healthy coaching relations" because the "presence of evaluation prejudices the necessary willingness to show weakness and vulnerability." (p. 238).

"Change is a journey" (Fullan & Miles, 1992, p. 749), and a guided journey is necessary to effect change. An alternative model for professional development focusing on teacher collaboration may establish mechanisms of consultation and support among teachers. Teacher collaboration, according to Little (1993), can also prepare teachers to employ techniques and perspectives of inquiry and provide teachers with a means of recognizing and acting upon the connections among students' experiences in the classroom. According to Guskey (1985), collaboration which offers crucial support for teachers by providing technical feedback on learning outcomes, guiding them in adapting new practices to meet the needs of students, and helping them analyze the effects on students, is coaching. Although there are different forms of coaching, *cognitive coaching* is an effective technique that can be utilized. Cognitive coaching is nonjudgmental, relies on trust, facilitates mutual learning, and enhances growth towards working independently with others (Costa & Garmston, 1994). Cognitive coaching serves to improve teachers' instructional effectiveness by encouraging them to be more reflective about their teaching (Garmston et al., 1993).

Reflection

Professional development that encourages collaboration to help teachers move away from teacher isolation and secure curriculum implementation, according to Hargreaves and Dawe (1990), embraces reflective practice. Reflective practice, these authors maintained, brings about principles of practicality, collegiality, and reflection as basic premises for professional development. They also stated that "reflection . . . is identified within this area of research and professional development as constituting the very heart of professional knowledge and action" (p. 230).

"Reflection is not the same as introspection," according Mezirow (1991, p.15), because introspection is "becoming aware of the fact that one is perceiving, thinking, or acting in a particular way" while "all reflection involves a critique" (p. 15). Reflection, Mezirow maintained, is "the intentional reassessment of prior learning to reestablish its validity by identifying and correcting distortions in its content, process, or premises" (p.15). We, therefore, reflect not only on content or descriptions of a problem but also on the strategies and procedures involved in the problem solving process during the course of an action or afterwards (Mezirow). Hence, when we "stop and think" about what we do or have done we engage in reflection (p. 104). As a result, we engage in reflection when we identify similarities and differences between what has been learned previously and what is being learned "to identify—principles, make generalizations, identify patterns of data, select appropriate ways of expressing our concepts, create metaphors for extending meaning beyond the data as given, and decide on next steps in problem solving" (Merizow, p.105). Reflection is also considered, according to Vygotsky (1981a), as "the transferal of argumentation to an internal level" (p. 158). It is thinking about one's thinking and is also known as metacognition. When this is "applied to teaching, it is frequently called 'reflective teaching'" Greene (1992, p. 132).

The continuous problem-solving process that the professional development context lends itself to is one in which choices between different courses of action may not be clear cut but highly dependent on individual judgment. Thus, according to Hargreaves and Dawe (1990), using Schon's terminology, individuals are constantly engaged in "reflection-in-action. Also, when the action is over, they also engage in "reflection-on-action" (p. 230). Therefore, when individuals are not given a procedure that will lead to the solution to a problem, according to Dewey (1933), the demand for the solution to such "a perplexity is the steadying and guiding factor in the entire process of reflection" (p. 14). The process of reflection is spawned by the interactive discourses in the collaborative community.

It is the interactive discourses generated by the experiences that occur during acts of collaboration that raise one's consciousness and propel reflective thinking. Therefore, "the development of an idea through reasoning helps supply intervening or intermediate terms which link together into a consistent whole" (Dewey, 1933, p. 112). Thus, the nature of reflective practice as adopted within the educational setting for collaborative professional development increases teachers' knowledge, according to Hargreaves and Dawe (1990), "from an image of anti-intellectual habit of unquestioned experience" and an "uncritical adoption of proven technical procedures . . . to one of skilled and thoughtful judgment exercised in practical situations" (p. 230).

The reflective practice that fosters the "development of a discourse genre in which constructive discussion, questioning, querying, and criticism are the mode rather than the exception" will eventually become internalized as self-reflective practices (Brown, 1997, p. 406) because, according to Vygotsky (1981a), "the relations among higher mental functions were at some earlier time actual relations among people" (p. 158). Dewey (1933) supported the idea that reflective thinking results from the coming together of individuals communicating about and engaging in a state of uncertainty, perplexity, and mental difficulty in which thinking originated and in the acts of searching and inquiring. Looking back upon the past, individuals are helped to resolve doubts and settle perplexities (Dewey). Central to the process of reflection, Grimmett (1988) noted, is the paradox that one cannot know without acting, and one cannot act without knowing. This paradox also finds expression in Maturana and Varela's (1998) aphorism that "all doing is knowing, and knowing is doing" (p. 26).

Tabak et al. (1998) emphasized that reflection is stepping back and evaluating actions, progress, and understanding in order to effectively construct explanations or justify progress. Many times, according to Dewey (1933), reflection encourages a comprehensive synthesis as previously disconnected ideas are integrated into one consistent whole. Also, according to Dewey:

> Reflection is an operation in which facts on one side and meaning on the other are elicited through constant interaction with each other. Each newly discovered fact develops, tests, and modifies an idea, and every new idea and new shade of an idea lead to further inquiry, which brings to light new facts, modifying our understanding of facts previously observed. (p. 165)

Thus, reflection arises from situations in which individuals are personally involved and in direct experiences which initiate puzzles and surprises (Grimmett, 1988). According to Vygotsky (1981a), "Reflection is spawned from argument" (p. 165). As a result, the conclusion drawn is always tentative and subject to further examination as individuals reason and elaborate on issues. These actions provide experimental corroborations for the conjectured ideas. Thus, reflection always leads to a consequence (Grimmett, 1988), and the "function of reflective thought is, therefore, to transform a situation in which there is experienced obscurity, doubt, conflict, disturbance of some sort, into a situation that is clear, coherent, settled, harmonious" (Dewey, 1933, pp. 100-101). To do this, one must make inferences. Inference, according to Dewey, is the "process of arriving at an idea of what is absent on the basis of what is at hand" (p. 95). Every inference, Dewey contended, "involves a jump from the known into the unknown" (p. 96) because it goes beyond the ascertained and known facts which are had either by observation or recollection of prior knowledge. Thus, "reflective thinking involves a look into the future, a forecast, an anticipation, or a prediction" (p. 117), transcending the immediate goals of an interaction to make meaning of an experience. Hence, reflection involves looking back and looking ahead (Grimmett, 1988) as individuals engage in mediational discourses.

Mediational Discourses

Mediational discourses are concerned with the quality of interaction between or among human mediators. The verbal and non-verbal interactions that are a part of mediational discourses may include the three parameters: "intentionality-reciprocity, transcendence, and meaning" irrespective of the language of the particular culture (Feuerstein and Feuerstein, 1991, p.16). These authors maintained that although verbal interaction may be minimal during a discourse, the mediational aspect is not necessarily diminished, because "the verbal, symbolic modality of mediation is more powerful than the purely gestural or action." They further stated however, that "not all verbal interaction bears the nature of intentionality to mediate" (p.16).

Consciously or unconsciously, an individual's cognitive structures become modified by mediational discourses. This interactive engagement "serves as the basis for the mental processes that takes place within the individual; . . . [and] produces in the individual the propensities to learn from, and become modified by, these experiences"(Feuerstein & Feuerstein, 1991, p. 13) as the mediational *tools* are employed to bring about reflection. According to Feuerstein and Feuerstein, "modifiability is directly determined by the quality of interaction between the organism and the environment which becomes possible only by mediated learning experiences" (p. 13). Hence, the mutual questioning and answering that shape the dialogic-interaction of mediational discourses provide a personal experience that allows "a high level of cognitive, self-reflective, insightful processing" (p. 19) to take place.

When an interaction "is shaped by the intention to mediate to the mediatee, not only the particular stimuli, activity, or relationship, but also to share this intention with the mediatee," it satisfies the condition of intentionality (Feuerstein & Feuerstein, 1991, p. 17). When this implicit intent is turned into an explicit volitional and conscious act, the process of reciprocity has taken place (Feuerstein & Feuerstein). The quality of interaction produced by intentionality and reciprocity leads to the development of higher mental processes. According to Feuerstein and Feuerstein, a deeper analysis of the mental processes generated

> by the interaction animated by intentionality and reciprocity reveals that this modality of interaction, even when done on elementary levels, creates in the mediatee an awareness of the learning process and of the didactic principles underlying it. The metacognitive components form an important part of the mediational interaction, taking the form of induced self-reflection, insight, and articulation of the total field into its components. This orientation, once internalized, becomes the steering power towards more efficient learning, and in turn, leads to higher levels of modifiability. (Feuerstein & Feuerstein, p. 20)

In addition to intentionality and reciprocity is another important component: mediation of transcendence. Transcendence is "the orientation of the mediator to widen the interaction beyond the immediate primary and elementary goals" (Feuerstein & Feuerstein, 1991, p. 21). It "creates in the mediatee a propensity to enlarge his cognitive and affective repertoire of functioning constantly" (p. 21). Individuals who are exposed to particular mediational experiences, Feuerstein and Feuerstein insisted, "will continue, implicitly or explicitly, to mediate what has become a part of himself to his mediatees" (p. 21). When individuals are exposed to the mediation of transcendence, their cognitive structures are meaningfully affected in various ways. As a result, according to Feuerstein and Feuerstein, it is "transcendence that makes the human individual modifiable and in a constant state of change" (p. 22). Also, transcendence not only takes an individual beyond the immediate goals of an experience to include more remote goals but it also changes in many ways the means employed to achieve these goals (Feuerstein & Feuerstein).

Mediation of meaning, the third component, is concerned with the dynamic and energetic dimension of the interactions. Mediation of meaning seeks answers to the questions why and what for and the reasons something happens or is done (Feuerstein & Feuerstein, 1991). In many cases, during interactions, the implicit reasons for certain interactions are neither made explicit nor shared with those we engage with in discourse. However, when the interaction is animated by the intent to transcend, the meaning of the interaction is mediated to the mediatee. As a result, the significance of the interaction, the implicit reasons for the "why's" and "what for's" of the primary as well as the secondary goals of the interaction are made explicit (Feuerstein & Feuerstein). With the use of elegant linguistic tools (Costa & Garmston, 1994) or the use of more complex verbal modalities for the mediation of meaning, an orientation toward a search for meaning is created in the mediatee. Once this need is internalized, it "becomes the source of independent modes of functioning and decision making" (Feuerstein & Feuerstein, 1991, p. 25).

In determining the quality and formative power of the interaction, the mediation of meaning has two major roles to play. First, the mediator's attempt to mediate the purposes of the interaction is rendered efficient; second, the mediatee is endowed "with the need to look for meaning in the wider sense of the term" (Feuerstein & Feuerstein, 1991, p.26). This search for meaning goes beyond the immediate goal of the mediator's efforts to convey particular meanings to include the reasons for relationships. Feuerstein and Feuerstein averred that

> The product of the transcending quality of this mediation is of the highest value in the orientation for the search for meaning and significance and has important bearing on the modifiability of the cognitive structure of the individual and the continuous widening of his need system. (p. 26)

Hence, the mediated propensity of the individual to search for and construct meanings is the dynamic determinant of the changes and transformations he or she will undergo to achieve the more remote goals (Feuerstein & Feuerstein, 1991) in a collaborative setting. Consequently, the discourse generated within a collaborative setting is a tool for teacher empowerment and professional enhancement as grounded reflections are generated for the development of curriculum, pedagogical reforms, and new approaches to instruction (Hargreaves & Dawe, 1990). Cognitive coaching provides a safe forum for professional dialogue and aids in the development of skills for reflection on practice, both of which are necessary for productive collaboration (Costa & Garmston, 1994).

Cognitive Coaching

Cognitive coaching, according to Costa and Garmston (1994), "is a nonjudgmental process built around a planning conference, observation, and a reflecting conference" (p. 2). It is the application of specific strategies, a way of thinking, and a way of working. Metaphorically, to Costa and Garmston, it is like a stage coach serving as a means of conveyance: conveying an individual on an intellectual trip "from where he or she is to where he or she wants to be" (p. 2). Cognitive coaching, rooted in the clinical supervision theories of Cogan and Goldhammer, is an expression of the third type of clinical supervision that promotes teacher reflection and the enhancement of teachers' intellectual growth (Costa & Garmston, 1994; Garmston et al., 1993).

This clinical supervision model demands a change in role so that teachers and supervisor can work as colleagues, respecting each other's contributions (Costa & Garmston, 1994). This approach to clinical supervision emphasizes collegiality that aids the professional development of a responsible teacher who is analytical about his or her performance, open to help from others, and self-directive (Grimmet & Creman, 1990). In the clinical supervision modes, supervisors work with teachers to identify and resolve teaching-related problems, set challenging goals for themselves, and assist them in developing innovative approaches (Goldhammer et al., 1993). Clinical supervision is a move away from the supervision model that is "compatible with the long-held metaphor of teaching as labor where management sets standards, directs how the work is to be done, monitors and reviews for compliance, and then evaluates and rewards the completed work" (Costa & Garmston, 1994, p. 5). In the supervision model, supervisors assume an expert, superior role and teachers are told what should be changed and how it ought to be done. However, in clinical supervision, the change is made to a process that encourages the cultivation of self-appraisal and self-supervision (Costa & Garmston, 1994). According to Goldhammer et al. (1993), the primary vehicle for building a collaborative relationship between teacher and supervisor is a good system of communication.

Cognitive coaching, an expression of the third type of the clinical supervision model, embraces the new paradigm of industrial management that focuses on a trusting environment and views the keys to corporate success as growth and empowerment of the individual (Costa & Garmston, 1994). It is a "people-based art" that presumes the relationship that "teaching is a professional act and that coaches support teachers in becoming more resourceful, informed, and skillful professionals" (p. 5). The primary difference between cognitive coaching and evaluation in the supervision models is that cognitive coaching uses conferencing cycles for the sole purpose of helping teachers improve instructional effectiveness by becoming more reflective about their teaching (Costa & Garmston).

The goals of cognitive coaching, Costa and Garmston (1994) stressed, are the establishment and maintenance of trust; the facilitation of mutual learning, which is the engagement and transformation of mental processes and perceptions; and the enhancement of growth toward holonomy. *Holonomy*, they noted, is defined as "individuals acting autonomously while simultaneously acting interdependently with the group" (Costa & Garmston, p.3).

Costa and Garmston (1994) maintained that "coaching . . . occurs within a relationship that is action oriented, result oriented, and person oriented," where individual creativity is enhanced, relationships are revolutionized, and a trusting environment is created in which "growth and empowerment of individuals are the keys to corporate to success" (p. 5). The ultimate goal of cognitive coaching is teacher autonomy—the ability to self-monitor, self-analyze, and self-evaluate (Garmston et al., 1993).

A cognitive coaching relationship may be established between two professionals with similar roles or between peers (Costa & Garmston, 1994). Costa and Garmston posited that teachers who wish to continually enhance their expertise in teaching never lose their need to be coached. They also wrote that "the coach need not be a more expert performer than the person being coached" because "technical expertise frequently is less relevant than the ability to enable or empower people to move beyond their current performance" (p. 5). In a study utilizing cognitive coaching that lasted for four months, in which Linder and Whitaker were the teachers and Garmston was the coach, Garmston et al. (1993) stated that "we did not know one another prior to beginning the program; . . . the coaching relationship was consultative rather than reciprocal" (p. 58). As a result, they concluded that cognitive coaching can apply to reciprocal or consultative arrangements of peer or supervisory coaching (Garmston et al.).

Cognitive coaching allows for effective mediation by a coach who constructs and uses clear, precise language to facilitate another person's cognitive development (Costa & Garmston, 1994). It diagnoses and envisions desired states of others and devises an overall strategy through which individuals will move themselves toward desired states (Costa & Garmston). Costa and Garmston maintained that the cognitive coaching relationship is one that views teaching as a professional act in which coaches help teachers become more resourceful, informed, and skillful professionals. Teachers' overt behaviors are changed as a result of refined perceptions and cognitive processes because the cognitive coaching process incorporates the basic principles of knowledge construction (Costa & Garmston).

Cognitive coaching enhances the teachers' intellectual capacities; as a result, the intellectual achievement of their students is also enhanced (Costa & Garmston, 1994). Garmston et al. (1993) found that the coaching process helped teachers internalize and use the coaching behaviors of gathering data, questioning, probing, and paraphrasing with their students. They also found that the reflection learned through cognitive coaching helped teachers develop problem-solving skills as they examined their experiences, generated alternatives, and evaluated their actions (Garmston et al.).

Cognitive coaching, according to Garmston et al. (1993), does not require teachers to follow a formula nor does it present a preconceived template for correct instruction. Instead, it supports the teachers' existing strengths while expanding previously unexplored capacities. It also provides teachers with the opportunity to talk aloud about what they are thinking; thus, their decisions become clearer and their awareness increased (Garmston et al.).

Studies employing the process of cognitive coaching have resulted in positive outcomes for teachers in collaborative settings. Teachers who received training in cognitive coaching expressed significantly higher satisfaction with education as a career than those who did not (Edwards & Newton, 1995). Teacher efficacy has also been influenced by cognitive coaching (Edwards, Green, Lyons, Rogers, & Swords, 1998;

Edwards & Newton, 1995). According to Edwards and Green (1999), teachers trained in cognitive coaching were more concerned about the needs, welfare, and learning of students than a control group, who were more concerned about their own performance. School culture has also been affected by the employment of cognitive coaching because the process tended to bring about greater enthusiasm for teaching by those who participated (Edwards & Newton, 1995). According to Edwards, Green, and Lyons (1998), teacher empowerment was increased by the utilization of strategies that fostered mutual respect; encouraged teachers to take ownership of change; gave teachers choices, responsibility, and autonomy; encouraged collaboration and self-evaluation; and promoted independence.

Costa & Garmston (1994) noted that "cognitive coaching promotes cohesive school cultures where the norms of experimentation and open, honest communication enable everyone to work together in healthy respectful ways" (p. 8) and in areas such as collaboration, decision-making, problem-solving, and networking. It creates the climate, environment, and context that empower individuals to generate results (Costa & Garmston).

Garmston et al. (1993) found that, during the cognitive coaching experience, observations by the coach were unobtrusive and did not lead to teacher anxiety. Although the coach maintained a mediatory stance, whenever teachers solicited information because they needed the information and were not able to produce the ideas for themselves, the coach moved to a direct stance of providing information (Garmston et al.). They also found that cognitive coaching raised their consciousness to a self-evaluatory and self-analysis level at which they internalized the questions they were asked by asking themselves the same questions. Costa and Garmston (1994) also stated that, because the coach's questions focus teachers' attention on learner objectives and ways of evaluating them, teachers begin to automatically think in this way. According to Foreman (1995), opportunities to develop trusting, collegial relationships for sharing in a nonjudgmental environment ought to be provided so that teachers can reflect on their beliefs and construct their own understanding. One major element to bring about successful collaboration that is facilitated through cognitive coaching is trust (Costa & Garmston, 1994).

Trust

Cognitive coaching is about building trust first, then thinking afterwards. In the development of relationships, trust must be established (Johnson, 1997). Researchers (e.g., Costa & Kallick 1993; da Costa, 1993, 1995; da Costa & Riordan, 1997) have found that a level of trust is needed for teachers and their teaching partners if teacher growth is to take place through teacher collaboration. Trust, according to Costa & Garmston (1994), is a prerequisite for successful cognitive coaching relationships. It is also necessary for successful collaboration among and between teachers (da Costa & Riordan, 1997). To build trusting relationships, time should be provided, information should not be used for summative evaluation purposes, and patience should be exercised (da Costa & Riordan). Also, da Costa and Riordan noted that, when trust exists in a relationship, anxiety about the collaborating process is nonexistent or minimal. da Costa & Riordan found that highly efficacious teachers were more likely to trust others and to take risks. Smith (1998) found that two groups in a reflective seminar involving teachers, a university supervisor, administrators, and administrative interns, during four meeting times in a practicum semester, were unable to establish trust and feelings of safety that supported deep thinking and risk-taking. He concluded that his finding was not surprising because the literature has revealed that it takes time to build trust in a learning community (Smith). To build trust in any group, openness is needed to develop a supportive climate (Cragan & Wright, 1999; Johnson, 1997). Openness needs to exist for "the sharing of information, thoughts, and reactions about issues being discussed" (Johnson, 1997, p. 75) and for the offering of resources with others to help them achieve their goals.

Greene (1992) stated that researchers in the Medicine Hat professional development project initially believed that if teachers would learn to trust each other in order to observe and work with each other and to help each other analyze their own teaching, their teaching would magically improve. However, even after three years, Greene reported, the content of most conferences and teacher discussions focused mainly on relatively low-level and non-threatening behaviors. She further stated that only after three years could teachers begin to reflect on, analyze, and try to address more complex teaching behaviors and student outcomes.

The essential ingredients for the building of trust include the following: recognizing how one relates to others of similar or dissimilar cognitive styles and knowing how to network, how to draw on the resources of others, and how to value each person's expertise and appreciate differing views, perceptions, and knowledge bases (Costa & Garmston, 1994). It is trust that allows one to process and make meaning of learning (Costa & Garmston). Consequently, trust needs trust to build TRUST; it is a symbiotic process. Trust is essential for the development of relationships, especially "in cognitive coaching where teachers are encouraged to inquire, speculate, construct meaning, self-evaluate, and self-prescribe" (Costa & Garmston, p. 36). Coaches help create the climate for teacher experimentation by building trust in four areas: "trust in self, trust between individuals, trust in the coaching process, and trust in the environment" (Costa & Garmston, p. 36). Trust establishes the foundation for the observation and analysis of one's teaching (da Costa, 1993) and is achieved through the creation of a nonjudgmental climate and through verbal and nonverbal behaviors, approaches, or language tools (Costa & Garmston, 1994).

The Trust-Building Tools of Cognitive Coaching

The "non-judgmental verbal approaches that contribute to interpersonal trust" include "structuring, silence, clarifying, and providing data" (Costa & Garmston, 1994, p. 46). These are embedded in the language of coaching and are also considered trust-building *tools*.

Paraphrasing

Paraphrasing, one of the nonjudgmental accepting responses, is a verbal behavior for the building of trust (Costa & Garmston, 1994). Paraphrasing is "rephrasing, recasting, translating, summarizing, or giving an example of what" (p. 49) is said during an interactive discourse. It is a means employed to maintain accuracy of meaning and intent of an idea or set of ideas (Costa & Garmston). Also, according to Leont'ev (1981),

> Meaning is not in a word and not in the speaker's soul and not in the hearer's soul. Meaning is the effect of the interaction of the speaker with the listener on the material of the given sound complex. . . . Only social interaction involving speech gives the color of its meaning. (p. 254)

Paraphrasing is also an important communication strategy for clarifying ideas which are being discussed (Cragan & Wright, 1999). According to Costa and Garmston (1994), it is possibly the most powerful nonjudgmental verbal response because the listener strives to communicate that he or she is trying to understand the speaker and also values what is said. Paraphrasing, Cragan and Wright (1999) further observed, is an excellent way to assure the speaker that one is listening.

Probing and Clarifying

A *probe* is a statement made to elaborate a response to a question. It can take the form of a question (Borich, 1988). It serves the purpose of eliciting clarification, soliciting new information to extend and build a particular response, and redirecting or restructuring the response in a more productive direction. According to Borich, in eliciting clarification, the listener rephrases or rewords a response so that a determination can be made about the appropriateness or correctness of the response. He further stated that probes elicit new information by pushing the response to a new and more complex level of understanding. This type of probe, explained Borich, "builds higher and higher plateaus of understanding by using the previous response as a stepping stone to greater expectations and more complete responses"(p. 209). He also stated that "it involves treating incomplete responses as part of the next higher level responses—not as wrong answers" (p. 209). Probes, Borich stated, can also be posed for the purpose of redirecting the flow of ideas without indicating directly to the speaker that he or she is on the wrong track. Therefore, probes redirect responses into a more productive direction to accomplish a needed shift less abruptly and less negatively, but initiate a move to a higher level involving generalizations, abstractions, and the drawing of inferences (Borich).

Clarifying, Costa and Garmston (1994) noted, contributes to trust building because it communicates the idea that expressed thoughts are worth consideration and exploration although the full meaning is not yet realized. It is also a signal that the coach needs more information (Costa & Garmston). Clarifying is often framed in the form of a question or a statement inviting more information. This questioning technique provides a vehicle for the full exploration of necessary information and opinions regarding the particular topic under discussion (Cragan & Wright, 1999). The intent of probing and clarifying, Costa and Garmston (1994) maintained, is to help the coach understand more clearly the coachee's ideas, feelings, and thought processes and is also a *tool* for the building of trust.

Silence and Wait-time

An essential consideration during probing is how long to wait before initiating another question (Borich, 1988). Borich observed that wait time can be as effective in contributing to a desired response as is a question or a probe itself because it allows the responder to thoughtfully compose a response of his or her own. Borich recommended that a wait time of at least three seconds should be observed before either asking another question or repeating the previous question; however, when questions are likely to require thinking through and weighing alternatives, up to 15 seconds of wait time may be appropriate. The studies of Rowe; Tobin; and Tobin and Capie, (as cited in Borich, 1988) suggested that when wait time is increased to three seconds or longer, the length of responses increased, the number of voluntary responses increased, and participants asked more questions and showed more confidence in their responses, whereas failure to respond decreased.

According to Costa and Garmston (1994), silence during conferencing serves to indicate that the conference is a productive one because a coach who waits is communicating respect for the teacher's reflection and processing time. It also demonstrates respect for the coachee's ability to perform a complex cognitive task. Waiting for an answer is a desirable behavior that demonstrates thoughtfulness and reflection and serves to restrain impulsive tendencies on the part of the coach. Costa and Garmston insisted that, if trust is the goal, then coachees should have the opportunity to do their own thinking and problem solving. They further stated that coaches who wait for longer periods receive answers with complete sentences and thoughts. They also noticed a perceptible increase in the creativity of the coachee's responses.

Structure—Conferencing

A trusting, safe relationship exists between two individuals when what is expected of each is understood (Costa & Garmston, 1994). However, when expectations are not clear, one's energy and mental resources are spent both in trying to interpret hidden cues about what the other person wants and in trying to detect hidden agendas. However, as a result of the structure provided by conferencing, the coach's expectations and purposes are clearly and deliberately communicated because each individual in this relationship knows what is being focused on. A common understanding of the purposes of observation is generated by such structuring (Costa & Garmston).

Conferencing provides structure for planning, observation, and reflection, and is essential in bringing about the collaborative setting of the cognitive coaching process. The probes generated by the questions *in situ* of the conferencing map signal the need for information.

The planning conference. A planning conference, according to Costa and Garmston (1994), allows coaches to mediate by engaging in deep pre-active mental rehearsal through questioning and paraphrasing. Planning involves four basic components:

1. Anticipating, predicting, and developing precise descriptions of students' learning that is to result from instruction;
2. Identifying students' present capabilities or entry knowledge;
3. Envisioning precisely the characteristics of an instructional sequence or strategy that will most likely move students from their present capabilities toward immediate and long-range instructional outcomes; and
4. Anticipating a method of assessing outcomes which will provide a basis for evaluation and making decisions about the design of the next cycle of instruction (Costa & Garmston, 1994, p. 90).

The planning conference serves to refine lesson strategies, identify gaps or inconsistencies that might exist in the original thinking, and help the teacher anticipate decisions he or she will have to make "on his or her feet." Decisions become clearer and awareness is increased (Garmston et al., 1993) because detailed mental rehearsal is provided for during the planning conference. This establishes the parameters for the reflecting conference (Costa & Garmston, 1994).

According to Costa and Garmston (1994), after experiencing a number of planning conferences, teachers begin to automate this way of thinking about most lessons. They begin to internalize the conference questions by asking themselves what their objectives are, what strategies they will use, and whether these are the most effective, and how they will know students are learning (Costa & Garmston; Garmston et al., 1993).

The lesson observation. The coach's role during the lesson is specified during the planning conference. Data are gathered upon request of the coachee, with judgmental comments being withheld because they are counterproductive to any trusting relationship (Costa & Garmston, 1994). Costa and Garmston maintained that "praise can be as damaging to trust as criticism and other put downs" (p. 48). Judgmental evaluations have limited impact on behaviors; neither do they stimulate thinking. Positive feedback puts a "lid" on a person's capacity, whereas negative feedback shuts down or narrows a person's thinking, solicits negative reaction, and inhibits experimentation (Costa & Garmston).

Costa and Garmston (1994) strongly advocated that information gathered during this process should be recorded and presented in terms free from judgment and inferences, but in a form that encourages thinking and gives people choice. This is an important aspect of cognitive coaching because the trend is to move away from performance appraisal to empowerment as inner thought processes are altered to impact overt behaviors.

The reflecting conference. Nurturing the teacher's capacities for processing information through comparison, inference, and the drawing of causal relationships is a main objective of cognitive coaching (Costa & Garmston, 1994). Data should be available for the teacher to process. Therefore, during the lesson observation, whatever the means of data collection decided on to gather information, data should be presented during the reflecting conference in a nonjudgmental, non-threatening, and non-confrontational manner (Costa & Garmston).

Costa and Garmston (1994) found that reflecting conferences which give teachers opportunities to summarize and share their impressions of a lesson and to recall specific events are very important because the teachers are the only participants judging performance or effectiveness. By inviting teachers to make comparisons between the lesson and what was desired from the planning stage, the coaches facilitate teachers' analysis of lesson objectives by providing data and using reflective questioning. Teachers will therefore draw causal relationships between their actions and student outcomes. As the reflecting conference continues, the coaches encourage teachers to propose how future lessons might be different based on new learning, discoveries, and insights that have been gained. Teachers are also invited to reflect on the coaching experience itself, giving feedback about what has been learned and providing suggestions for refinement or changes that might make the relationship more productive (Costa & Garmston).

By building trust and rapport through the formal process of the planning conference, observation, and the reflecting conference, a coach can help create cognitive shifts that bring about observed changes in overt behaviors desired by the coachee (Costa & Garmston, 1994). This may be done through a collaborative process with a trusted colleague (Costa and Kallick, 1993) and will also help the coachee to recognize his or her own behaviors utilizing the *diagnostic tools*.

The Diagnostic Tools of Cognitive Coaching

The *diagnostic tools* of cognitive coaching are constructs a coach can use to assess the cognitive development of individuals and groups and plan interventions (Costa & Garmston, 1994). According to Vygotsky (1978), "Applying as tools not only those objects that lie near at hand, but searching for and preparing such . . . as can be useful in the solution of the task, and planning for future actions, . . . constitutes the central subject matter for any analysis of the origin of uniquely human forms of behavior" (p. 26). The diagnostic tools also serve as transitory, transforming, and transformable energy sources.

These energy sources are transitory because they are influenced by a variety of factors, including experience, knowledge, fatigue, emotion, and familiarity (Costa & Garmston, 1994). They are transforming, Costa and Garmston explained, because an increase in performance is based on an increase in these energy sources; for example, one's state of confidence will influence how one performs at a particular moment. They are transformable because one's own conscious awareness of these energy sources allows one to choose to change them. In-the-moment competence can also change the state of confidence; as well, others' recognition of whether one is high or low in terms of these energy sources can lead to change in the particular level (Costa & Garmston). Therefore, the sources of an individual's growth emanate from the diagnostic tools, the energy sources, and/or the five states of mind—efficacy, interdependence, flexibility, consciousness, and craftsmanship—which are the foundation for trust and rapport (Costa & Garmston).

Taken together, the *diagnostic tools* are a force directing one towards increasingly authentic, congruent, ethical behavior. They are considered primary vehicles in the lifelong journey toward integration. Costa and Garmston (1994) advocated that assisting others towards refinement and expression starts with self—that is, with one's own state of mind—and then emanates to others, to the system of which one is a part, including one's students. An individual's conscious awareness of his or her states of mind can influence the individual to choose and change, or another person can encourage that individual and thereby change in that moment his or her state of mind, leading to the enhancement of the individual's efficacy.

Self-Efficacy

To attain certain levels of performance, individuals may at times create self-inducements to persist in their effort until their performances match self-prescribed standards (Bandura, 1977). Many may react in self-rewarding ways conditional to the attainment of prescribed levels of behavior. One can therefore posit that such individuals are self-motivated because they set standards against which to evaluate their performance. However, beliefs that individuals hold about their capability play an essential role in their success. Individuals' beliefs about their capabilities to produce designated levels of performance which exercise influence over events that affect their lives are defined as their perceived *self-efficacy* (Bandura, 1977; 1994). Self-efficacy beliefs determine how individuals feel, think, behave, and motivate themselves (Marzona, 1992).

In this conceptual system, both the initiation and persistence of coping behaviors are affected by expectations of personal mastery. The strength of many individuals' convictions concerning their effectiveness to perform certain tasks at desired levels is likely to affect whether or not they will even try to cope with given situations (Bandura, 1994). Because of their doubt about their capabilities, individuals shy away from difficult tasks because they are seen as personal threats (Bandura). Their perceived self-efficacy at the initial stage influences the choice of activities in which they may become involved. When faced with any degree of difficulty, Bandura contended, individuals with a low sense of efficacy dwell on personal deficiencies, obstacles they will encounter, and adverse outcomes, rather than concentrate on how to perform the task successfully. Through fear, they tend to avoid threatening situations that they believe exceed their coping skills, they give up quickly, and they slacken their efforts. Recovery of their sense of efficacy is slow whenever failure or a setback is experienced. On the other hand, they get involved in activities and behave with assurance when they judge themselves capable of handling those situations that would otherwise be intimidating (Bandura, 1977).

Bandura (1994) asserted that a strong sense of efficacy enhances an individual's sense of accomplishment and personal well-being in many ways. Individuals with a high assurance of their capabilities approach difficult tasks as challenges to be mastered rather than threats to be avoided. Such efficacious propensity "fosters intrinsic interest and deep engrossment in activities" (p. 71):

> Not only can perceived self-efficacy have directive influence on choice of activities and settings but, through expectations of eventual success, it can affect coping efforts once they are initiated. Efficacy expectations determine how much effort people will expend and how long they will persist in the face of obstacles and aversive experiences. The stronger the perceived self-efficacy, the more active the efforts. Those who persist in subjectively threatening activities that are in fact relatively safe will gain corrective experiences that reinforce their sense of efficacy, thereby eventually eliminating their defensive behavior. (p. 193)

Individuals with a high sense of efficacy set challenging goals, maintain strong commitments, and heighten and sustain their efforts in the face of failure or setbacks. Such individuals, according to Bandura (1994), attribute failure to insufficient effort or deficient knowledge and skills which are acquirable. Such an efficacious outlook produces personal accomplishments, reduces stress, and lowers vulnerability to depression because threatening situations are approached with the assurance that control can be exercised over them (Bandura).

Bandura (1977) commented that efficacy expectations vary in terms of several dimensions and may have important performance implications. *Vicarious experiences* provided by social models are another way of creating or strengthening an individual's sense of efficacy. Bandura emphasized that seeing others who are perceived as similar to oneself succeed will help generate expectations in observers that they, too, can succeed if they persist and intensify their efforts, even though activities might seem threatening; whereas, in the same vein, seeing others fail despite high efforts can lower observers' judgment of their own efficacy and undermine their effort. Bandura (1994) maintained that the impact of modeling on perceived self-efficacy is strongly influenced by the perceived similarity to models. The greater the perceived similarity, the stronger the influence of the model's success and failures.

Beliefs in personal efficacy affect life choices, levels of motivation, the resilience exercised in the face of adversity, quality of functioning, and vulnerability to stress and depression. Beliefs in perceived self-efficacy may be influenced by four main sources: mastery experiences, vicarious experiences, verbal or social persuasions, and emotional or somatic states (Bandura, 1994). To succeed at anything, individuals must develop "a robust sense of efficacy" (p. 81) and sustain a persevering effort because this is a powerful state of mind that influences behavior.

Flexibility

Flexibility is the ability to step beyond oneself and view a situation from a different perspective (Costa & Garmston, 1994). Flexible individuals are cognitively empathic and view situations through multiple perspectives. Flexibility involves "paying attention to detail, precision, and orderly progressions" (p.135). According to Costa and Garmston, "it is intuitive, holistic, and conceptual," and is strongly related to problem solving in that one is able to see the larger picture although parts of the picture might be missing.

Flexible individuals are aware of each person's uniqueness and constantly seek to expand their repertoire so they can sense, search for, and detect cues about another person's thinking processes, beliefs, modality preferences, and styles in order to communicate effectively and to develop trust (Costa & Garmston, 1994). Like efficacy, flexibility is related to risk-taking, it is strongly related to problem-solving, and it might be enjoyed as a challenge as alternatives are envisioned (Costa & Garmston). Flexible individuals entertain the capacity to be open and tolerant, to change their minds and receive additional data as they seek and create novel approaches (Costa & Garmston).

Interdependence

"No man is an island, entire of itself; every man is a piece of the continent, a part of the main" (John Donne, 1624. Devotions upon Emergent Occasions, no. 6). According to Costa and Garmston (1994), interdependence is a two-way relationship, one way gives help and the other receives help; one influences, and one is influenced. When the channel exists for teachers to pool their ideas, each will become more efficient than any one person by himself or herself (Costa & Garmston).

Humans, according to Costa and Garmston (1994), grow in reciprocity to others. Vygotsky (1978) maintained that every function in cultural development appears twice: first at the social level and later at the individual level; first, between people and then inside, because higher functions originate as actual relations between individuals. Social interdependence exists among individuals continually, and according to Johnson and Johnson (1999) is "one of the most fundamental and ubiquitous aspects of being human" (p. 4). It affects all spheres of our lives, including the degree of our productivity, the quality of our relationships, and the state of our psychological health (Johnson & Johnson). When individuals share their concerns and resources, the end product is usually richer than if they try to make the "journey" alone. Therefore, although time limitations, isolation, and limited peer interaction have prevented teachers from meeting together, school leaders should realize that for teachers to grow professionally, they need to seek collegiality and commit themselves to group goals and needs (Costa & Garmston, 1994).

Collegiality between members of a learning community means teachers working diligently, practicing in exemplary ways, keeping abreast of new ideas, helping other members of the learning community to succeed, and working in groups instead of individually (Sergiovanni, 1991).

Consciousness

Consciousness is the knowledge of what is happening around oneself and the totality of one's thoughts, feelings, and impressions. It is an awareness of events internal and external to oneself (Costa & Garmston, 1994). Consciousness is brought about as one interacts with others and through what is written and through reflection. Costa and Garmston advocated that it is a prerequisite to self-control and self-direction. Individuals who experience appropriate levels of consciousness monitor their own values, thoughts, and behaviors, and advance toward their goals. Teachers will mentally rehearse, edit mental images, and seek to improve and accommodate the possibility of alternative strategies while they generate and apply internal criteria for the decisions they make (Costa & Garmston).

Craftsmanship

Expert performers take pride in their work (Costa & Garmston, 1994) and strive for precision and excellence. Perfection and excellence in performance are the heart and soul of craftsmanship (Costa & Garmston). Costa and Garmston maintained that individuals who seek perfection and elegance, refinement and specificity, generate and hold clear goals and monitor their progress toward these goals. They also recognize that language and thinking are closely entwined; therefore, they constantly strive to enhance the clarity and specificity of their thoughts and language. They also strive for exactness in critical thought processes and precise language for describing their work. They reflect upon how their ideas and feelings are being expressed, trying to determine whether they are being expressed with clarity, meaning, thoughtfulness, and elegance, and always seeking ways to enhance further precision and craftsmanship (Costa & Garmston).

According to Costa and Garmston (1994), as teachers are led to examine and metacogitate about their performances in the classroom, becoming more flexible, interdependent, and conscious about the desired outcomes on the part of students, they will seek to enhance their craftsmanship in order to effect the highest state of achievement on the part of their students. Students will also seek to improve their craftsmanship as teachers move from using traditional modes of teaching to more promising alternative modes.

Alternatives to Traditional Instruction in Mathematics

The traditional mathematics classroom has been tied to the dissemination of knowledge and validation of answers for students, who are expected to learn alone in silence (Silver & Smith, 1996) pondering formulas (Silver, 1996). The emphasis on this traditional mode of instruction is generally one in which the teacher lectures and the students take on the passive role of listening (Campione, Brown, & Connell, 1988). In mathematics education, the traditional way that mathematics is taught leads to students' inability to make lateral and vertical transfers of their mathematical knowledge. According to Campione et al., many students acquire a distorted view of academic tasks as they come to believe that mathematics is the process of acquiring facts, executing procedures, and "running off well-practiced algorithms"(p. 96). The knowledge and skills students seem to acquire "tend to be encapsulated and inert, available only when clearly marked by context, . . . but not serviceable in other circumstances as tools for learning" (Campione et al, p. 100). In many cases, the result has been a lack of conceptual understanding.

In the Third International Mathematics and Science Study (TIMSS, 1996), it was found that U.S. and German eighth-grade mathematics teachers' goals for their lessons were usually to have students acquire particular skills or to learn how to do something, whereas Japanese teachers' goals resembled those of the recommendations of the U.S. reform as stated in the Standards, which include exploring, developing, and understanding concepts or discovering multiple solutions to the same problems. The study reveals that in the U.S., 90% of seat-work time was spent on routine procedures, in comparison to 89% in Germany, and 41% in Japan. In 44% of Japanese, 4% of German, and less than 1% of U.S. lessons, students were assigned to invent new solutions, proofs, or procedures on their own, which required them to think and reason. The TIMSS also found that U.S. teachers rarely led students to develop concepts, in contrast to German and Japanese teachers, who usually did. In Germany, teachers usually did the mental work in developing the concepts, whereas the students listened or answered short questions designed to add to the flow of the teacher's explanation. Japanese teachers, on the other hand, designed lessons in such a way that the students themselves derived the concepts from their own struggle with the problems (TIMSS, 1996).

Fisher (1998) queried, "Can new teaching approaches make a difference?" (p. 92). According to Fisher, findings from the discipline of cognitive science suggest that the traditional teaching method, in which the teacher transmits information to students who are expected to memorize and regurgitate it on command, is less effective than other approaches which encourage explorations with guidelines set out by the teacher.

For the development of reflective thinkers, a process by which students are empowered mathematically to take charge of their own learning (Campione et al., 1988), improve their mathematical performance (Lester, 1988), experience meaningful mathematics (Brown, Ferrara, Reeve, & Palincsar, 1991; Garofalo & Lester, 1985), and become efficacious, one probably has to think of alternate approaches that involve grouping for instruction.

Grouping for Instruction in Mathematics

Grouping for instruction has been explored by examining the traditional modes of teaching in the classroom which include the individualistic, competitive mode of learning; peer tutoring that embraces a novice/expert relationship; and the larger group-setting using cooperative learning, which perpetuates individualistic mastery of a sub-task but which embraces a setting in which information is shared to contribute to the progress of the group. Student collaboration as an interactive process with learners working jointly on given tasks during the collaborative learning process which might employ discourse in a conducive classroom climate has also been explored.

Individualistic Learning

Individualistic learning (Johnson & Johnson, 1999) has been fostered throughout the years by the traditional mode of teaching in the classroom context. Individualistic learning, according to Johnson and Johnson, "is working by oneself to ensure one's own learning meets a preset criterion independently from the efforts of other students" (p.7). Individualistic learning has been one of the tools employed to foster one of the most widely recognized aspects of interpersonal interaction in any society, competitive learning (Johnson & Johnson). Competitive learning, according to these authors, "is the focusing of student effort on performing faster and more accurately than classmates. Students perceive that they can obtain their goals if and only if the other students in the class fail to obtain their goals" (p. 6). In a typical traditional classroom setting which promotes individualist and competitive learning, students are encouraged to have and use their own set of materials, work at their own pace, try not to disturb classmates, and seek assistance only from the teacher (Johnson & Johnson). Students in this setting, according to Johnson and Johnson, are expected and encouraged to focus on their own goals, maintain a strict self-interest, and recognize that their own success depends on their own abilities.

Even though individualistic competitive learning has been encouraged by this mode of instruction, many students as well as teachers have recognized and used the power that resides in working with others for a common good (Johnson & Johnson, 1999). Thus, they have been working with one another to foster each other's performance and bring about cooperative learning. Cooperative learning, according to Johnson and Johnson, "is the instructional use of small groups so that students work together to maximize their own and each other's learning"(Johnson & Johnson, p. 5). Working in small groups has taken several forms as various group sizes are utilized in the classroom setting to optimize learning. One such type of instruction, Damon and Phelps (1989) insisted that "represents a large step away from the traditional 'direct transfer' model" (Damon & Phelps, p. 10) is peer tutoring.

Peer Tutoring

Peer tutoring, Damon and Phelps (1989) explained, is a mode of instruction in which one child instructs another in material on which the first is considered an expert and the second a novice. It is generally assumed that the tutor, whether on a permanent or temporary level, has greater competence and more information than the tutee (Damon & Phelps). The roles of students can be reversed, with the tutor becoming the tutee and vice versa, depending on who has more mastery of a particular concept.

Damon and Phelps (1989) explained that peer tutoring emulates the traditional teacher-student relationship in which one party transmits expertise to another. This assumption, they maintained, follows the pattern of the instructional model that assumes that knowledge is passed from person to person in a linear manner rather than being co-constructed through collaboration with one another. Because students do not have equal status in this instructional relationship, the engagement is low in terms of equality ~~in re~~lation to other forms of peer discourse (Damon & Phelps).

Cooperative Learning

Cooperative learning, Hilke (1990) asserted, is an organizational structure which uses team-based learning approaches with no more than five or six students on each team in which students pursue academic goals through collaborative efforts, drawing on each other's strengths to complete a prescribed task. Success is attainable by each person, who is responsible for his or her own learning and for assisting others (Hilke, 1990; Johnson & Johnson, 1999). Students' perceptions in the cooperative learning setting are that they are able to reach their goals if and only if the other students in the learning group also reach theirs (Hilke, 1990; Johnson & Johnson, 1999; Quin, Johnson, & Johnson, 1995; Wren & Schmidt, 1991). The term *"cooperative learning,"* according to Wren and Schmidt, is a subset of the collaborative possibilities in that it is narrower and refers to a context in which students work together, contribute to each other's progress, and in which the teacher organizes tasks or projects and students carry them out in small groups (Wren & Schmidt) or learning teams.

Learning teams are generally heterogeneous with respect to ability; a sense of superior status is rarely attached to any roles; and, as a result, cooperative learning values equality (Damon & Phelps, 1989). In this structure, there is a division of responsibility for mastering the assigned task. Each member of a group is self-assigned or group-assigned specialized roles; each becomes an expert on a sub-task; and this information is then shared with the group for the understanding, presentation (Damon & Phelps, 1989; Hilke, 1990), and evaluation of the overall global task.

Antil, Jenkins, Wayne, and Vadasy (1998) examined the prevalence, conceptualization, and form of cooperative learning used by 85 elementary school teachers from six schools. It was found that a variety of approaches for forming cooperative learning groups were utilized. Most individuals reported that groups were characterized by heterogeneous grouping, students' selection of their teammates, random assignment, and convenience, for example, students who sat near one another.

Cooperative learning, according to Hilke (1990), provides supportive relationships, good communication skills, and higher thinking abilities. At times, however, the competitive element is introduced within and among groups; this forces students to work against each other, and when their performance is compared, they can lose self-esteem and sometimes experience negative feelings towards their higher-achieving peers (Hilke). Cooperative learning techniques that discourage competition between students foster a more favorable climate of collective activity (Damon & Phelps, 1989) and the development of social skills (Hilke, 1990).

Student Collaboration

Collaboration is an interactive process which occurs between individuals of similar status while working jointly on the same task rather than individually or on separate components, resulting in negotiation, mutual discovery, reciprocal feedback, and frequent sharing of ideas (Damon & Phelps, 1989; Dillenbourg, 1999). Collaboration allows students to experience shared responsibility and to share their expertise in the attainment of learning outcomes (Palincsar, Stevens, & Gavelek, 1989) and necessitates the participation and engagement in a coordinated effort to solve a problem or perform a task together (Dillenbourg, 1999). According to Dillenbourg, even though the terms *"collaborative learning"* and *"cooperative learning"* have been used interchangeably, collaboration requires more than the effective division of labor that constitutes cooperative learning.

Collaboration, Brown (1997) noted, is necessary for survival. She further stated that "this interdependence promotes an atmosphere of joint responsibility, mutual respect, and a sense of personal and group identity" (p. 411). An important issue for anyone, according to Cragan and Wright (1999), is social acceptance within the group setting. In a collaborative classroom setting, Slavin (1995) found that social relationships and achievement improved, whereas social relationships were less developed in traditional classes. In collaborative classrooms, students also felt that their classmates wanted them to learn. The main feature of the collaborative setting is that it affords students the opportunity to talk with each other as they work together on classroom activities. Through the interaction with others, they assimilate information and their ideas; thus, the critical element of communication is encouraged (Golub, 1988). Communicating effectively and developing trust within a group are essential for the level of output that the group desires (Hilke, 1990).

The interactions in the collaborative setting are negotiable (Dillenbourg, 1999). This is one of the main differences between collaborative interactions and the traditional hierarchical situation, in that group members will not impose their views on the sole basis of their authority but will, to a great degree, argue their standpoint, justify, negotiate, and attempt to convince others. Interactions in the collaborative setting, Dillenbourg maintained, are central to individual cognition because building an explanation is a cognitively demanding task which leads to learning.

Yackel, Cobb, and Wood (1991) stated that as part of a 3-year research and development project, in which a second-grade mathematics class in a constructivist learning environment engaged in small-group collaborative dialogue that preceded whole-class discussions, small-group problem-solving gave opportunities for learning that did not occur in traditional classrooms. This was the main instructional approach throughout the second year of the project. Active cognitive involvement, elaborations, and justifications in the absence of extrinsic rewards characterized the learning environment.

Dougherty et al. (1995) conducted a study which involved three large lecture sections consisting of 180, 180, and 240 students during the first term of a university chemistry course. Of the two smaller sections, one was the control presented in a standard lecture format, the other smaller section involved a limited amount of cooperative interaction and enhanced communication. The third larger section focused on enhanced communication in student-formed groups of three or four. The third section required substantial cooperative interactions which were provided in various ways. Problems on which students worked were generated by the instructor. Dougherty et al. found that enhanced communication and the techniques employed for group cooperation had a positive effect on both student learning and retention.

The opportunity for positive interdependence among students as they share the responsibility for learning is provided through student collaboration as their self-esteem is enhanced and their initiatives are encouraged (Hilke, 1990). This interdependence can be fostered if specific roles are assigned to group members to perform within the group (Hill & Hill, 1990). According to Cohen (1996), "The use of roles is a major teaching technique of delegating authority to groups; roles help manage the group process and can do much to foster interaction" (p. 13). Collaboration provides the framework that allows students to show what they can do (Dillenbourg, 1999; Golub, 1988). During interactions in the collaborative setting, "students will learn from one another because in their discussions of the content, cognitive conflicts will arise, inadequate reasoning will be exposed, and higher-quality understandings will emerge" (Slavin, 1995, p. 18). Consequently, what each learns while interacting with others in the group setting, he or she will be able to do on his or her own at a later date (Vygotsky, 1978).

Cohen (1996) cited a number of findings which showed a relationship between interaction and learning that holds at the individual level. Cohen, Lotan, and Holthuis (as cited in Cohen, 1996) observed a strong relationship between the rate of talking and working together and gains in achievement in mathematics in an elementary classroom. Also, Ben Ari (as cited in Cohen, 1996) found that, in elementary classrooms in Israel, interaction was related to gains in individual cognitive development, as measured by a standardized test on reasoning. Webb (1991), in a review of research on the importance of interaction in the small-group setting, found that giving explanations to teammates is positively related to achievement, whereas receiving non-responsive feedback from teammates is negatively related to achievement.

Students in a collaborative setting will generate thinking about their thinking, problem solve, and reflect. That is, they will be metacogitating—knowing *where, when, how, and why* certain knowledge can be used (Garofalo & Lester, 1985). This metacognitive environment, in which students are engaged in reflective practices most of the time, according to Brown (1997), generates an atmosphere of wondering, querying, and worrying about knowledge. Thus, students will be able to connect inert, encapsulated, fragmentary pieces of mathematical knowledge and experience meaningful mathematical insights (Brown et al., 1991; Garofalo & Lester, 1985) and improvement in performance. This experience will determine how well students can learn interdependently in a domain to empower themselves so that they can take charge of their own learning (Campione et al., 1988; Hilke, 1990; Lester, 1988). Vygotsky (1981a) affirmed this by stating that

> any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane. First it appears between two people as an interpsychological category, and then within the child as an intrapsychological category. (p. 163)

According to Brown (1997), effective learners operate best when they access their own repertoires of strategies for learning and insights into their own strengths and weaknesses. Vygotsky (1981a) commented that "any higher mental function was external because it was social at some point before becoming an internal, truly mental function" (p. 162). Thus, "all higher mental functions are internalized social relationships" (p. 164). This type of knowledge and control over thinking, Brown affirmed, has been termed *metacognition*.

In examining cooperative and competitive efforts in individual problem solving, Quin et al. (1995) conducted a meta-analysis on 46 studies which spanned the period between 1929 and 1993. They found that cooperation resulted in higher-quality problem-solving than did competition. When pure operationalizations of cooperation were compared with mixtures of cooperation and competition, results were similar. Cooperation resulted in more effective problem solving than competition in all types of problems. They also found that the difference between elementary school students, secondary school students, college students, and adults was not statistically significant ($F(1, 59) = 0.27, p<.61$).

Groups working collaboratively can be formed by students' choice, randomly assigned, or assigned by the teacher (Golub, 1988). Self-chosen groups may be more motivating for some individuals who find it important to work with friends or those whom they see as potentially friendly. The combined experiences of all group members allow for the richness involved in learning particular content and problem solving (Hill & Hill, 1990). In addition, working collaboratively promotes more positive attitudes towards the subject area being studied as well as their teachers, greater competency in working with others, and continual opportunities for the development of leadership skills and group skills (Hill & Hill).

From a meta-analysis of 3,000 published articles examining the effects of within-class grouping on student achievement at the elementary, secondary, and post-secondary levels, Lou et al., (1996) found that within-class grouping appears to be a useful means to facilitate student learning, especially in large mathematics and science class situations. They also found that small teams of three or four members seem to be more effective than larger groups. Also, low-ability students seemed to benefit most when placed in mixed ability groups; however, medium-ability students benefited most in relatively homogeneous ability groups (Lou et al.).

The collaborative learning process. Collaborative learning takes place in a setting where teaching is done indirectly. The teacher poses the problem and organizes students in groups to derive solutions collaboratively (Bruffee, 1993). Collaborative learning replaces the traditional classroom social structure where there is a negotiated relationship among students and a negotiated relationship between student communities and the teacher (Bruffee, 1995). This alternative classroom social structure, according to Bruffee, allows students to cultivate and "learn the craft of interdependence" (p. 1). It also helps them become autonomous, articulate, and socially and intellectually mature, learning concepts "not as conclusive facts but as the constructed result of a disciplined social process of inquiry"(Bruffee, p. 17).

In collaborative learning, students focus on tasks (Bruffee 1993); they learn to depend on one another instead of depending exclusively on the teacher. They learn to construct knowledge socially in small groups (Bruffee, 1995) "as it is constructed in the academic disciplines and profession" (Bruffee, 1993, p. 1). According to Bruffee, collaborative learning assumes that knowledge is a consensus among members of a community of knowledgeable peers. It is something that people construct while talking together and reaching an agreement. Bruffee also claimed that collaborative learning "provides the essential conditions for mobilizing peer-group influence . . . in order to lead students to the heart of the intellectual process, if one understands that knowledge is socially constructed and learning is a social process" (Bruffee, p. 6).

After knowledge is constructed within the collaborative groups, it is tested socially in the larger community of the class as a whole, and then by the larger professional community represented in the classroom by the teacher (Bruffee, 1995). The "nesting of smaller knowledge communities within increasingly larger ones both constructs the authority of knowledge and is the principal tool for evaluating, confirming, and, when necessary, revoking that authority" (Bruffee, p. 17).

The values of collaborative learning have been documented (e.g., Bruffee, 1993; Dillenbough, 1999; Dougherty et al., 1995; Quin et al., 1995; Silver, 1996) as promoting healthier cognitive, social, and physical developments along with higher self-esteem, positive relationships, positive attitudes towards one another, and mutual feelings of respect and support. These are strengthened by the climate generated by the group process, which is not evaluated (Bruffee, 1995). The group process, according to Bruffee, is the quality of relationships that group members work out and maintain among themselves. Teachers grade students individually, and grades are not based on group effort but on individual effort after students show the application of what they learned collaboratively in written form (Bruffee), probably in response to an assignment or test.

Collaborative learning, Bruffee (1995) declared, defines only one social role, the recorder, whose responsibility is to record the group's discussion and consensus and speaks for the group in the whole-class situation. Who will take on a particular role at various times in the collaborative setting is the decision of the group. Group governance, according to Bruffee, is the responsibility of the group. Group accountability is furthered because teachers do not intervene in learning groups; or, if they do, it is on well-defined conditions. Teachers are encouraged to respond to questions about substance, procedure, or social roles by returning those questions to the groups for them to be resolved (Bruffee, 1995). Also, the correctness of a response or solution in the collaborative learning setting is "seldom absolute" (p. 17). Correctness in this setting is more likely to be considered in relation to a current consensus in the larger community of the classroom. Differences of opinion are encouraged (Bruffee).

Questioning each other within groups is a necessary and an inevitable aspect of collaborative learning (Bruffee, 1995). This questioning provides a vehicle for the full exploration of necessary information and opinions regarding the discussion topic (Cragan & Wright, 1999) so that a reciprocal understanding and negotiation of meaning can be established (Dillenbourg, 1999). The "need for reciprocal understanding . . . has been highlighted as an essential prerequisite for collaborative learning (Dillenbourg). The utilization of the tools of communication, which include questioning and offering of opinions and explanations, promotes the generation of discourses. The study of collaborative learning, according to Dillenbourg, has a relatively brief history.

Discourse. *Discourse* is "the ways of representing, thinking, talking, agreeing and disagreeing" (NCTM, 1991, p. 34) that teachers and students use to engage in tasks central to what students learn about mathematics in the classroom. According to Lappan (1997), discourse includes not only the ways ideas are represented, but how they are exchanged and modified into more powerful and useful ideas. Also, as noted in the Standards: "The discourse of the mathematics class should be founded on ways of knowing and ways of communicating (NCTM, 1991, p. 54). Hicks (1995) noted that the term *discourse* implies socially-situated communication that sustains face-to-face interactions between participants or in the case of written texts, between author and reader.

According to Geé (1996), discourse co-ordinates and integrates words, signs, acts, values, thoughts, beliefs, attitudes, and social identities, as well as gestures, glances, body positions, objects, and settings. Discourse is also a "tool for the establishment and distribution of knowledge" (Riley, 1985, p. 2) in a social interaction. As participants collaborate, they exchange information and learn one another's meaning; thus, common meaning is created through sharing and comparing information (Riley, 1985). This interaction requires negotiation of meaning, according to Riley, and this negotiation he referred to as discourse. Riley also noted that "This interactivity is a necessary condition for the enactment of any discourse" (Riley, p. 7).

Discourse does not consist simply of a succession of turns involving grammatically well-formed utterances, just talk, or just language (Gee, 1996), but a combination of and interrelationships among a number of systems which include language, tone of voice, gesture, body position, physical proximity, eye contact, and facial expressions, all woven together to form the fabric of a conversation (Riley, 1985). This exchange allows for understanding that enables those involved to understand what is being said and allows the speaker to understand what is being understood, so that the intended "information content" (Johnson & Marrow, 1981, p. 95) is conveyed and understood. According to Hodge (1993), it is also a process by which meanings are understood and passed from one to another by some means of exchange. It is shaped by the tasks in which one engages as well as the culture of the learning environment (Hodge) and includes "both the way ideas are exchanged and what the ideas entail" (NCTM, 1991, p. 34).

Discourse, as conceived here, integrates the essence of the definitions provided by Gee (1996), Hicks (1995), Johnson and Marrow (1981), the NCTM (1991), and Riley (1985). Namely, it involves ways of knowing and ways of communicating the substance of ideas that integrates words, thoughts, actions, beliefs, values, attitudes, gestures, social identities and nonverbal expressions and is sustained in an interactive setting. It is a tool used for the establishment and distribution of knowledge to gain the intended messages which one strives to communicate through language. Vygotsky (1978) stated that it is both natural and necessary for speech to accompany action during any problem-solving activity: "Speech not only accompanies practical activity but also plays a specific role" (p. 25) because it is "the unity of perception, speech, and action, which ultimately produces internalization of the visual field" (p. 26).

Discourse has become a major theme for educational reform because many educators have come to realize that inquiry learning cannot take place in a setting of direct instruction where the teacher or textbook holds the key to knowledge in the form of right answers. As a result, many educational reforms which have made discourse a focal point of reform have done so through a socio-cognitive or socio-cultural theoretical framework (Hicks, 1995). One main educational reform group that exemplifies a focus on discourse, the NCTM (1989, 1991), has initiated changes in forms of classroom communication. Three of the six educational standards developed for the teaching and learning of mathematics are devoted to discourse: the teacher's role, the students' role, and the role of tools for enhancing discourse (NCTM, 1991; Hicks, 1995). Silver (as cited in Cohen, 1996) described the reform vision of mathematics classrooms as places in which students engage actively with the mathematics they are asked to learn, in which discourse is a prominent feature of classroom activity, and in which personal meaning-making and understanding are important goals of the socially-situated classroom activity.

The Classroom Climate

The climate generated in the classroom that focuses on discourse is one that encourages participation and communication. Teachers and students alike participate. The teacher orchestrates or facilitates academic discourses situated in the everyday communication practices of the students who engage in verbal conjecturing, questioning, and explaining as they develop their mathematical power (NCTM, 1991; Hicks, 1995). The opportunities provided during discourses in a mathematics learning context allow students to make public their conjectures while they reason with others about mathematics; as a result, "ideas and knowledge are developed collaboratively" (NCTM, 1991, p. 34). Hence, the development of mathematical skills or procedures is no longer the focus, but one that is attuned to the development of conceptual understanding (Hicks, 1995; NCTM, 1991). To develop conceptual understanding, learners need to reflect and listen carefully to each other's ideas and establish trusting relationships (Foreman, 1995).

According to the NCTM Standards (1991), for teachers to achieve the desired or maximum effect in bringing about classroom discourse, questions and tasks should be designed to elicit, engage, and challenge each learner's thinking. This is done in an environment in which everyone's thinking is respected, reasoning and arguing about (mathematical) meanings is the norm, and each learner feels free to ask questions to clarify and justify ideas orally and in written form (NCTM, 1991). Discourse also involves the ways of talking and forms of reasoning inherent in the solution process of a problem, explaining to peers how solutions are arrived at and engaging in an interaction about other possible solution paths (Hicks, 1995). Working with students to improve the level of discourse is time well spent because it is another way to foster interaction (Cohen, 1996). Interactional acts are realized by the structure of the discourse (Riley, 1985). This interactive structure is understood in terms of who speaks to whom when, which provides insights into the nature of roles (Riley).

Turns, then, may be realized verbally as well as non-verbally (Riley, 1985). The teacher's degree of discourse control is directly related to his or her right of address. However, if the teacher is in control, students cannot initiate an exchange; they have to wait until they are addressed. Consequently, only the teacher can produce opening and closing turns (Riley). The most direct form of role challenge possible in this situation is to "try to wrest the control of discourse away from the teacher, which explains why teachers have traditionally been opposed to talking in class" (p. 46). According to Lappan (1997), the implication of incorporating new forms of discourse into the classroom is a challenge for teachers' professional development. Many teachers never experience learning mathematics in situations where value is placed on the quality of thinking, the quality of explanations or argument, and the quality of decisions made; they also have had little or no experience in the use of intellectual tools (Lappan).

Writing is also an important component of discourse since it will provide explanations and justifications for mathematical ideas and solutions (NCTM, 1991). This view was also supported by Hicks (1995), who stated that in constructing mathematical discourse, a written record of the solution processes of a mathematical problem serves as an added dimension.

As learners listen to, respond to, and question each other, they communicate, reason, make connections, and solve problems while discourse is promoted in the learning situation (NCTM, 1991). To convince themselves and each other, they investigate conjectures by exploring examples and counter examples and seek to determine the validity of the particular representations, solutions, and answers collaboratively (NCTM, 1991). During discourses, the problem-solving activity, according to Vygotsky (1978), is divided into two consecutive parts: planning "how to solve the problem through speech and then carr[ying] out the prepared solution through overt activity" (p. 76). This speech (discourse) "precedes the action. It functions then as an aid to a plan" (p. 28) and serves as a verbal appeal to another person to fill the gaps in his thinking, resulting in a "syncretic whole" (Vygotsky, 1978, p. 29). Discourse is enhanced as learners use the tools of metaphors, stories, explanations, arguments, invented terms and symbols, graphs, diagrams, and oral presentations (NCTM, 1991).

As a result of participation in meaningful social activity, students learn academic discourses (Hicks, 1995). As teachers set the stage for this learning process, Hicks suggested that discourses can take place in small-group conferences. These academic discourses, she posited, are negotiated situationally within the classroom context in which meaning is constructed through social interaction because students are able to make the transition from one type of discourse to another. This transition, according to Vygotsky (1981a), emerges in either of two ways, directly or by mediation. He further stated that "it goes without saying that the higher form of social interaction, mediated by sign, grows from natural forms of direct social interaction" (Vygotsky, p. 160).

In an analysis of mathematical discourses of four videotaped Japanese and American fifth-grade mathematics lessons, Stigler, Fernandez, and Yoshida, (1996) found that (a) Japanese teachers, in contrast to American teachers, placed students' thinking at the core of their lesson-planning process; (b) Japanese lessons more than American lessons provided students with more opportunities to think during instruction; and (c) during Japanese lessons, an atmosphere is created in which students' thinking is valued and legitimized to a greater extent than during American lessons. Lampert (1990) also generated a setting in which students' ideas were valued as teacher and students engaged in mathematical discourse as mathematical tools and their meaning were explored. These mathematical tools, Lampert asserted, included language and symbols. This discourse engaged learners in risk-taking as they were given the opportunity to express their interests, ask questions, and gain understanding relating to the given mathematical problems. Cragan and Wright (1999) found that by utilizing communication skills in the areas of problem solving, role playing, team building, and trust building within groups, students' productivity, quality of work, and member satisfaction improved.

To develop certain pedagogical practices, academic discourses often embrace the ideal practices of an academic discipline (Hicks, 1995). For all students to participate in this authentic disciplinary discourse—the mathematical discourse—students experience changes in their roles in the academic discourses in the classroom. However, as students and teachers attempt to construct academic discourses, Hicks stressed that, " classrooms are embedded communities of discourse" and "can never be divorced from the community-based language practices that children bring with them" (p. 75). These discourses in the mathematics classroom are not just talk and action, but go beyond this level to involve reflection as students collaborate (Stigler et al., 1996) and engage in activities in which their roles are reciprocated as in reciprocal teaching.

Reciprocal Teaching

Reciprocal teaching, developed by Palincsar and Brown (1984), is an instructional method incorporating a learning procedure designed to train children in the application of specific, concrete, comprehension-fostering strategies that they can use to help them to better understand what they read (Brown & Palincsar, 1989; Palincsar & Brown, 1984; Palincsar et al., 1989). In this method, listening and reading comprehension are viewed as problem-solving activities that aim to promote thinking while reading (Alfassi, 1998) and embrace a group-setting in which the group provides social support, shared expertise, and role models (Brown & Palincsar, 1989).

The incorporation of guided practice is a major component of reciprocal teaching (Alfassi, 1998). The procedure takes the form of a dialogue between teacher and students regarding segments of reading text (Palincsar & Brown, 1984) in which the teacher provides expert scaffolding (Brown & Palincsar, 1987). Expert scaffolding offers a supporting context in which students may gradually acquire skills. Initially, the teacher's role is to enable each student to participate in this collaborative effort through instruction, modeling, and coaching, with the goal of gradually transferring the control of dialogues to the students (Palincsar et al., 1989; Rosenshine & Meister, 1994). The expert, the teacher, initially takes on the major task for the group activity, and the novices (the students) are encouraged to watch and then participate before they are able to perform the tasks unaided. The teacher models and then explains, relinquishing part of the task to the students only at a level that each one is able to negotiate at any point in time (Brown & Palincsar, 1987). This is done to facilitate a group effort between teacher and students as well as among students in the task of bringing meaning to the text.

This dialogue governed by guided practice involves the application of four strategies: (a) question generating, (b) clarifying, (c) summarizing, and (d) predicting (Brown & Palincsar, 1987; Campione et al., 1988; Palincsar et al., 1989). The articulation of these four strategies, according to Alfassi (1998), promotes understanding and monitoring of comprehension. Students take turns practicing the four strategies by assuming the role of dialogue leader. As the student becomes more competent, the teacher increases his or her demands, requiring participation at a higher level (Brown & Palincsar, 1987). All members of the group take turns serving as learning leaders responsible for orchestrating the discussion. When they are not leading, they support the discussion by offering their explanation of content, elaborating or commenting on other students' summaries, suggesting other questions, requesting clarification, or helping to resolve misunderstandings (Brown & Palincsar, 1989; Palincsar et al., 1989; Rosenshine & Meister, 1994).

Questioning is the first step in reciprocal teaching. This step was first designed in response to the overwhelming need to help students who failed to develop comprehension skills on their own (Brown et al., 1991; Campione et al., 1988). The strategies employed in reciprocal teaching promote comprehension and provide students with concrete methods of monitoring their understanding (Campione et al.). A major component of reciprocal teaching, according to Alfassi (1998), is the provision of a social setting that enables individuals to negotiate understanding because the provision for mediation is a group-learning activity in which students share responsibility for thinking.

Inquiry into reciprocal teaching began as a prototypical research project conducted in a laboratory under ideal conditions, where the instructor was an expert teacher/researcher and the students were hand-picked and carefully diagnosed as particularly in need of specific instructions (Brown & Palincsar, 1987). The ratio of students to teacher was favorable, one-to-one in the first study, and student groups of two in the second (Brown & Palincsar). Further research has aimed to transport the procedure to situations more representative of the pressures of normal classrooms.

Rosenshine and Meister (1994) reviewed research involving 16 studies on reciprocal teaching which contained both experimental and control groups in which students were assigned randomly to the two groups or the two groups were determined to be similar on initial measures of reading comprehension. The main instructional vehicle in all studies was the reciprocal teaching dialogue.

In one approach, explicit teaching of cognitive strategies took place for 4 to 20 days before dialogues began. In the second approach, all instruction took place during the reciprocal dialogue. When standardized tests were used as the outcome measure, all results were non-significant, indicating that there were no differences between the two approaches (Rosenshine & Meister, 1994).

Question generation was one of the strategies taught in all studies; however, only six studies assessed the students' ability to generate questions. In each of the six studies, students' performance in the reciprocal teaching group was superior to that of the control group on either the experimenter-developed comprehension test or on a standardized test. On the other hand, in five of the same six studies, it was found that, for the level of questions generated, the number of questions generated, or the rating of the quality of the questions, there was no difference between the reciprocal teaching group and the control group, that is, there was no relationship between the post-test measures for ability to generate questions and reading comprehension scores (Rosenshine & Meister, 1994).

Rosenshine and Meister (1994) compared studies which had significant results with those which had non-significant results and found no differences in results by (a) grade level (7-year-olds to adult), (b) number of sessions (6 to 100), (c) size of the instructional group (2 to 23), (d) number of cognitive strategies taught (2 to 10), or (e) whether the investigator or the teacher did the training. They found no decrease in the overall effect size for experimenter-developed comprehension tests when they used studies that had more traditional control groups, but the effect sizes for those studies using standardized tests were somewhat lower in the given context (Rosenshine & Meister).

However, on the other hand Lester (1988) suggested that reciprocal teaching "is a promising approach to metacognition-based instruction" (p. 119). Alfassi (1998) also reinforced this by stating that "reciprocal teaching is a viable instructional technique that can be implemented successfully within large, intact, remedial reading high-school classes as part of the curriculum" (p. 326).

The Role of the Teacher in the Discourse-Oriented Classroom

Designing learning environments that facilitate social interaction, cooperation, and collaboration in the regular classroom setting is being increasingly recognized as a need (Dillenbourg, 1999). According to Vygotsky (1981b), "for pedagogy" the use of language in social interactions has "great significance as a means of directing attention and as an indicator in the formation of ideas" (p. 229). The new role envisioned for teachers of mathematics is intimately related to communication (Silver & Smith, 1996) and discourse in mathematics education (Silver, 1996). Thus, students need to be encouraged by their teachers to learn to communicate mathematically, value mathematics, become mathematical problem solvers, and to reason mathematically (NCTM, 1989; Silver, 1996). Hence, notions of classrooms as discourse communities and teachers as facilitators of mathematical discourses are explicit concerning the new role of the teacher in order for students to develop conceptual understanding, problem-solving skills, the ability to communicate effectively, and their mathematical power (NCTM, 1991; Silver, 1996).

Several reasons have been posed for the emergence of communication as a focal issue in mathematics instruction, one of which is the socio-cultural perspective which suggests that "mathematical knowledge is as much socially constructed as it is individually constructed and that the practice of mathematics is fundamentally a social practice" (Silver, 1996, p. 129). Katz (as cited in Wren & Schmidt, 1991) argued that students should be active participants in their own learning because "there is no knowledge when students are lectured to without being queried or when they are not frequently asked to speak or write or apply their knowledge" (p. 246). Knowledge, Wren and Schmidt affirmed, is created, not transferred. Throughout the history of mathematics, according to Silver (1996), one finds that developments in mathematics often involve communication and social interaction as well as individual reflection and invention. This supports Vygotsky's (1978) claim that an essential feature of learning is that internal developmental processes are enacted only by interacting with and in cooperation with peers, and "Once these processes are internalized, they become a part of the child's independent developmental achievement" (p. 90). He also suggested that "what children can do with the assistance of others might be in some sense even more indicative of their mental development than what they can do alone" (p. 85). He further stated that "what a child can do with assistance today [he or] she will be able to do by [himself or] herself tomorrow" (Vygotsky, p. 87).

Therefore, as teachers engage students in the new vision of mathematics classrooms as discourse communities, students will be engaged in doing mathematics rather than having mathematics done for them (Silver, 1996) so that they will increase their ability to construct their own knowledge. Teachers will provide students with opportunities not simply to give answers, but to explain and justify their thinking and to discuss observations. Hence, classrooms will be learning communities where communication and justification are natural (Silver). With teachers challenging students to think and reason about their solutions to mathematical problems, students will have to communicate their solutions orally and in writing; therefore, they must be stated clearly and convincingly (Silver). Classrooms, according to Silver, will be transformed into situations in which communication and collaboration become central features of the classroom interactive discourses.

Teachers' judgmental comments will be suspended. Instead, questions should be posed so that students are stimulated to redirect, clarify, and extend their thinking (Greenes & Schulman, 1996; NCTM, 1991). Intellectual communities will have to be organized in which students work collaboratively, making sense of mathematics and relying on themselves and each other to determine whether something is mathematically correct and in which students believe that they can be successful mathematics thinkers (NCTM). There should be interest in and value and respect for each other's ideas as a result of exploring each other's thinking and asking probing questions which will encourage students to justify and explain their thinking and help them persevere when they face challenges (NCTM).

The teacher's role in the collaborative classroom is one of listening and questioning to ascertain whether or not he or she understands what the students want to express (NCTM, 1991) and to have students actively engaged in their learning. For teachers to be successful in this role, they have to be effective mediators. Mulchay (1991) maintained that the teacher's role as mediator is one in which the teacher helps students to become aware of their cognitive and metacognitive processes as well as their effect as they impact their learning. Hence, the teacher as mediator, Mulcahy further explained, "leads students to discover and deduce rather than teaching facts to them" (p. 387). Also, teachers as mediators will be "constantly challenging students to be more critical, systematic, evaluative, and strategic in their behavior and attitude toward learning" (p. 387) as they engage in collaborative learning communities.

With students in their learning communities, teachers need to create a climate in which "serious mathematical thinking can take place," in which genuine respect is fostered for each other's ideas, and in which reasoning and sense making are valued (NCTM, p. 57). Such a learning environment, according to the NCTM Standards, will "help all students believe in themselves as successful mathematical thinkers" (p. 57).

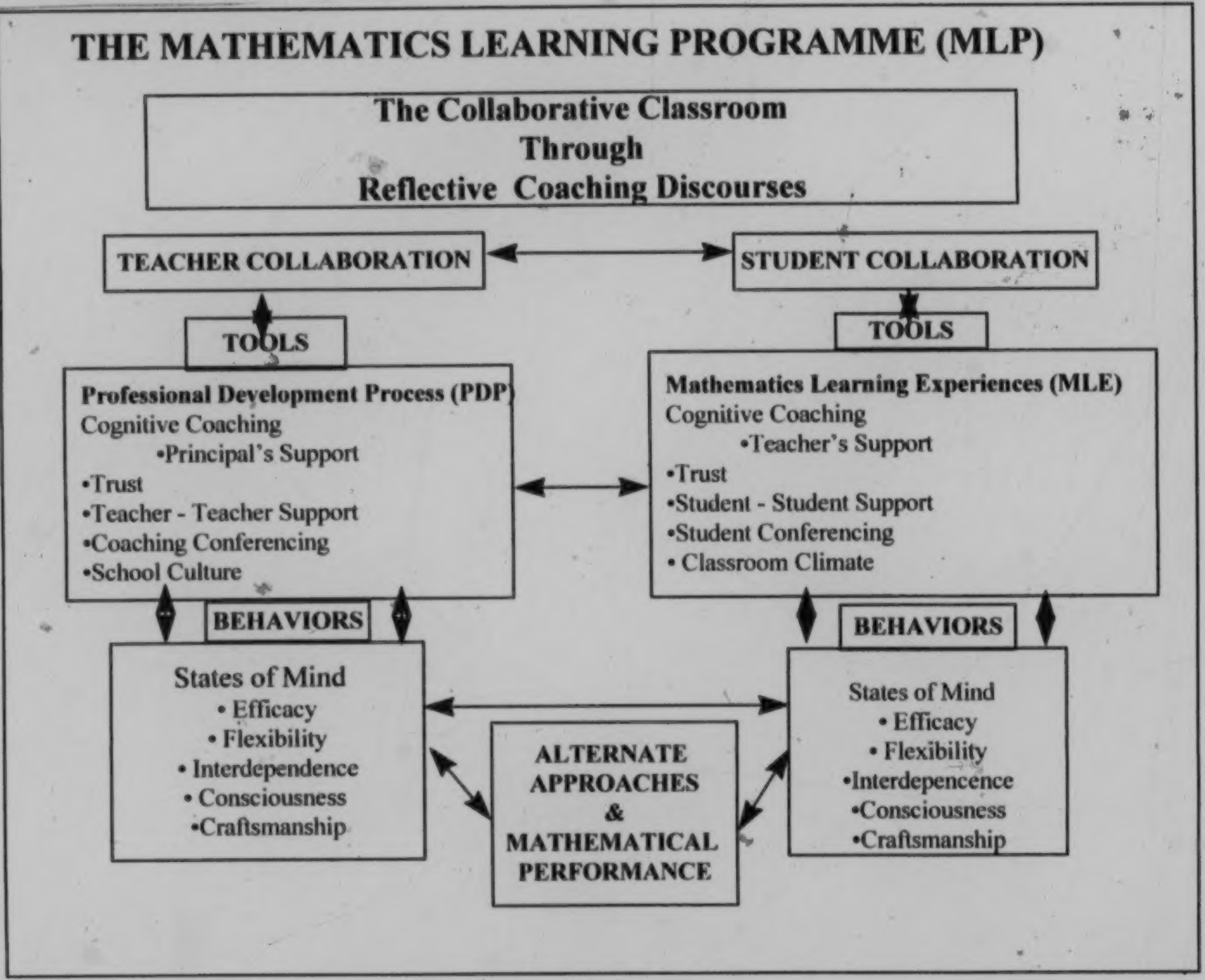
Peer collaboration, according to Silver (1996), has gradually become recognized as a significant contributor to student learning for both social and cognitive reasons. From the cognitive perspective, Silver stated, it has been argued that students are able to construct knowledge and elaborate their understanding through collaborative activity that they would not readily construct or elaborate while doing individual work. As students are encouraged by their teachers to engage in social mediation while interacting with others, they bridge their zone of proximal development (Vygotsky, 1978)—the "distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). As a result, "Individual cognitive development is therefore seen as a process of internalizing socially regulated and mediated knowledge" (Dillenbourg, 1999, p. 24). The processes that take place between a student and others become the basis for processes that subsequently will go on within the student. Therefore, the discussion, the questions, the explanations, and the interaction within the group become internalized as the basis for reflection and logical reasoning (Dillenbourg). Consequently, with teachers supporting this awareness and the use of classroom discourse, meaningful and socially organized learning will occur while learners are helped to develop intellectual habits upon which they can draw across a diverse range of situations (Dillenbourg).

According to Greenes and Schulman (1996), without communication a teacher will not be able to gain insight into what students know and are able to do; neither will they be able to make intelligent decisions about instruction. Communication growth allows students to bring forth their own deliberate thoughts and actions which are relevant to the problem situation through the acts of mediation on the part of the students themselves as well as on the part of the teacher. Therefore, the role of the teacher, in this context, is to pace and lead (Costa & Garmston, 1994) and to provide increased collaborative opportunities in the classroom to make the social dimensions of learning more salient (Silver, 1996) and thereby contributing to effective discourses and collaborative learning.

Conceptual Framework

To address the design and intent of this study, a conceptual framework had been generated, as illustrated in Figure 1. According to Miles and Hubberman (1994), "Conceptual frameworks are best done graphically, rather than in text" (p. 22). The conceptual flags are illustrated in the "bins" (boxes). I speculated that there is a parallel between the conception of the professional development process (PDP) and the mathematics learning experiences (MLE). Therefore, the arrows connecting the bins in this graphical conception reflect the reciprocity which existed between the major components—teacher collaboration and student collaboration—along with their sub-categories, which are all subsumed in *cognitive coaching discourses* and the *reflective coaching discourses*, an adaptation of the conceptual framework.

Figure 1. Conceptual framework.



CHAPTER THREE[2]

THE EXPLANATORY QUALITATIVE RESEARCH METHODOLOGY

> *Any fundamentally new approach to a scientific problem inevitably leads to new methods of investigation and analysis. The invention of new methods that are adequate to the new ways in which problems are posed requires far more than a simple modification of previously accepted methods. . . . In this case, the method is simultaneously prerequisite and product, the tool and the result of the study.*
> **(Vygotsky, 1978)**

The methodology for this study that addresses the conceptualization, introduction, accommodation, and development of an alternative approach for professional development for high-school mathematics teachers and for the teaching and learning of mathematics in the everyday classroom context is one that is of a qualitative research approach. This qualitative research approach is therefore specified and the research design is outlined in this chapter.

The research design includes gaining school access and establishing the Professional Development Process (PDP), the participants, the modes of data collection, the role of the researcher, the data analysis procedure, and the justification for the methodological approach. The question of trustworthiness as it relates to credibility, transferability, and confirmability; the delimitation and limitations; and the assumptions which are embedded in the theoretical and methodological stances of the study, along with the legal and ethical considerations, are also addressed. The development of the explanatory qualitative methodology for the development of the theory are also included.

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[2]

a. A version of this chapter has been prepared as part of a paper presented at the April 1998 American Educational Research Association Annual Meeting, San Diego, California, U.S.A., and has been published. Mclymont, E.F. & da Costa, J. L. (1998). ERIC Document Reproduction Service ED 420 637

b. A version of this chapter has been prepared as part of a paper presented at the 1998 International Multicultural Conference University of Alberta, Canada, and has been published. McLymont, E. F. (1998). International multiculturalism 1998: Preparing together for the 21st century, pp. 236 - 250.

c. A version of this chapter has been prepared as part of a paper presented at the 3rd African Society Conference 2000: Prospects for an African Renaissance. University of Alberta, Edmonton, Canada. February 2000.

Research Approach

The qualitative research approach taken for this study is naturalistic and inductive, and is concerned with process and meaning (Bogdan and Biklen, 1998). According to Bogdan and Biklen, "qualitative research is frequently called naturalistic because the researcher frequents places where the events he or she is interested in naturally occur" (p. 3). Context, therefore, is very important as the researcher feels that action can best be understood when observed in the setting in which it occurs because "human behavior is significantly influenced by the setting" (Bogdan & Biklen, p. 5).

In a qualitative approach, according to Bogdan and Biklen (1998), researchers tend to analyze data inductively. Theory developed emerges from the bottom up, from "disparate pieces of collected evidence that are interconnected." As a result, "theory is grounded in the data" (p. 6). Also, an essential concern to this qualitative approach is meaning, as "qualitative researchers are concerned with what are called participant perspectives" (Bogdan & Biklen, p. 7). The "two parts of the same process" explicitly involved in this approach are the emergence of theory and the doing of research (Strauss & Corbin, 1994, p. 273).

The interpretation of the perspectives and discourses which emerged during the multiple modes of data collection along with the voices of the participants (Strauss & Corbin, 1994) are taken into account in the multiple-embedded cases (Yin, 1994). Interpretations are also sought for understanding the actions of the individuals involved (Strauss & Corbin, 1994) as meanings are explored during discourses to understand the context and conditions of the expressed ideas. Thus, this explanatory study provides the content for the development of formal and substantive theory, both of which are aimed at interpreting the actions and perspectives of the participants involved. This explanatory study is also aimed at transforming learning communities into collaborative, self-reflective communities of inquiry.

The research approach is concerned with process as well as outcomes or products because the qualitative strategies suggest how the expectations are translated into daily activities, procedures, and interactions (Bogdan and Biklen, 1998) in order "to discover its [their] nature" (Vygotsky, 1978, p. 65). This approach is aimed at examining the development of this study as utilized by various learning communities. Therefore, to understand the various aspects and interactions, a description of the nature of the relationship among and between the various aspects is offered (Capra, 1996). Thus, I concentrated "not only on the product of development but also on the very process" (p. 64), "the process of change" (Capra, p. 65), to understand its origin. As a result, the study takes the form of explanatory qualitative research.

The research methods employed were consistent with this approach. Also, the researcher's insight is the key instrument of analysis.

Research Design

This inquiry documented the process embedded in the Mathematics Learning Program (MLP). This process involved accommodating an alternative approach to teaching and learning through a professional development seminar series for teachers and the students' *mathematics learning experiences* in the classroom. Each aspect of the MLP did not exist on its own but served as a tool in the total production or transformation process.

In designing the study, I wrote a proposal addressing the question of what would be studied, how it would be done, and a justification of the importance of the study. The techniques of data collection involved in this qualitative research design included interviews, field work as researcher-participant, and a multiple-embedded case study. According to Bogdan and Biklen (1998), qualitative studies usually involve more than one data-gathering technique. An interview schedule was developed (see **Appendix A**) and included in the proposal with which I entered the field.

With this design, I sought to bring forth a study which could not be separated into independent parts but which was linked to form an inseparable whole. For example, each phase of the data gathering process was built on preceding ones and could not be separated. When data gathering, I tried to establish the pathways I pursued to establish the genesis of the actual relations among the basic components—the modes of data collection—which comprise the network of this study.

Gaining School Access

In mapping out the path for this inquiry in the school system, I sought an overt approach, seeking the co-operation of those who would be involved in the study. According to Bogdan and Biklen (1998), although this is probably the most widely used approach, there is no name for it, and although they suggested the term "co-operative style" (p. 74), I choose to name it "collaborative style."

I solicited the support and participation of the principals of two high schools, Dominion High and Jerusalem High (pseudonyms) in what I conceptualized initially as a twin project, the *professional development project* for the mathematics teachers and the *mathematics learning project* for the teachers' mathematics classes. Principals as "gate keepers," according to LeCompte and Preissle (1993), are individuals who can facilitate access to the desired group. The schools were selected on the basis of accessibility, convenience, and low pass rates in mathematics in the Caribbean Examination Council Examination (CXC). The two schools were within a one mile radius of each other, so traveling between schools was not tedious. I was acquainted with the principals of these two schools.

A letter requesting support for these projects was mailed to each principal and the chairperson of each school board because I was not in the country (see **Appendix B** for letters). I explained the nature of the projects and solicited each school's participation, including the principals' as well as the teachers' participation. The principals were asked to consider this experience as a professional development project for mathematics teachers in their schools. After permission was granted, I maintained a level of communication with each administrator. With the permission of the administration of the schools, eight mathematics teachers representing both high schools were invited to participate in this study (four mathematics teachers from each school).

Planning for any event takes time and energy, but executing the plan takes much more. Before returning home to Jamaica during the first week of June 1997, from the University of Alberta, Canada, I received a formal response from the principals about their School Boards' decisions to accommodate this venture in the school context (see **Appendix B**). After I returned home to conduct the study which I had proposed, I gave each principal an outline of my study in the form of a mini-proposal (Creswell, 1994), giving more details of my intent. This included a summary of the methodology which would be employed. Then I visited the principals to seek to effect the proposed program. Bogdan and Biklen (1998) advised that, "Even if permission is granted from up high without first checking with those below, it behooves you to meet those lower on the hierarchy to seek their support." Therefore, "Getting permission to conduct the study involves more than getting an official blessing. It involves laying the groundwork for good rapport with those with whom you will be spending time, so they will accept you and what you are doing" (p. 76).

It was the last few weeks of school before the summer vacation began; therefore, I met with the principals of both high schools separately to make plans for the five days of professional development seminars and work out feasible dates for teachers of both schools. First, I was privileged to meet with the principal of Dominion High. I met him, along with his vice-principal and head of the mathematics department. I shared the long and short-term goals for my study and explained what had been outlined in the letter and the mini-proposal sent to them previously. Again, I outlined my plans for the five-day professional development seminars, the monthly sharing sessions, and the other opportunities for teachers to translate their experiences of the seminars into the mathematics classroom. I also verbally requested their participation and affirmed what I had stated in my letter of request—that I would provide traveling costs for the teachers traveling to the seminar site and lunch for all participants for the duration of the seminars and the monthly sharing sessions throughout the term. Dates for the seminars were tentatively set.

I followed the same procedure for sharing my study with the principal of Jerusalem High. After meeting with both principals, I decided to request permission from the principal of Dominion High to conduct the seminars at his school, because he seemed to show more interest in my study than the principal at Jerusalem High. My decision was supported by Bogdan and Biklen (1998). They stated: "we advise you, the novice, to pick places where you are more or less a stranger…." because

> others in the setting in which you are doing research, if they know you well, are not used to relating to you as a neutral observer. Rather, they see you as a teacher

> or as a member of a particular group, as a person who has opinions and interests to represent. They may not feel comfortable relating to you as a researcher to whom they can speak freely" ((p. 52).

This discomfort was obvious from the reaction of the principal and teachers of Jerusalem High.

Following my meetings with the administrators of both schools, I met the four mathematics teachers from each school at their convenience to set up the initial individual interviews and to invite them to participate. These interviews had several purposes. I wanted to develop rapport with the teachers, to collect biographical information, to learn how they perceived their students, to inquire about their experiences and opinions regarding professional development, and to have them discuss teaching and learning as it occurred in their mathematics classes. All teachers were interviewed individually by June 18 before the first set of seminars began on June 24.

Establishing the Professional Development Process (PDP)

My study involved both teachers and their students in a symbiotic collaborative process. The professional development series is termed the Professional Development Process (PDP). My study consists of two phases. The initial professional development, Phase I, consisted of five full day seminars (three days, June 24 to 26; and two days, Sept. 4 and 5). As participant-researcher, I conducted the seminars, focusing on the use of the *tools* for cognitive coaching and *Discourses* in a collaborative setting. During the June seminars, the eight mathematics teachers (see Table 2) engaged in activities utilizing the *tools* for cognitive coaching and *Discourses* and reflected on their experiences. After the June seminars, Jerusalem High opted out of the study. In the remaining two days of the September seminars, only the participants from Dominion High participated. They revisited their experiences with cognitive coaching and *Discourses* and continued to explore more strategies and other dimensions of the trust-building *tools*. At this time, teachers also reflected on the salient features of cognitive coaching that they could adapt to their own teaching and learning of mathematics in their classrooms.

Phase II of my study began after the completion of the September seminars (see Table 2). Phase II continued the Professional Development Process (PDP), along with the students' mathematics learning experiences in the classroom. It also followed the four Dominion High mathematics teachers' "journey" as they embraced the Mathematics Learning Program (MLP) from September to December 1997. During this time, the teachers personalized ideas that were generated from the PDP seminars as they explored alternative approaches to the teaching of mathematics.

My original research design intended that the teachers coach each other in dyads twice per month throughout the term while I assumed the role of co-coach. The Dominion High school's timetable was originally scheduled to accommodate the teachers working in dyads. However, early in September, the timetable required rescheduling due to an administrative decision to accommodate new teachers to the department. Therefore, my role as coach and co-coach emerged as all the original coaching dyads were not able to meet due to the changes in the new time table. I served as supportive coach for Mrs. Scott during the school term while I acted as co-coach for the coaching dyad between Mrs. Sinclair and Mrs. Jacobson. Initially, I coached Mr. Lennox. However, after the coaching dyad between Mrs. Jacobson and Mrs. Sinclair was disrupted by an additional assignment for Mrs. Jacobson and later by the discontinued use of the MLP in the lower grades of the school, Mrs. Jacobson requested to be coached for her Grade 11 class. She was then coached by Mr. Lennox, after which a reciprocal coaching dyad emerged.

Conferencing sessions for each teacher varied due to various mitigating factors. Mr. Lennox had five conferencing sessions for his class that was using MLE, three with me, one with Mrs. Scott, and one for another class with Mrs. Jacobson. Mrs. Sinclair had three conferencing sessions, two with Mrs. Jacobson and me (as co-coach) and one with me as coach. Mrs. Jacobson had five conferencing cycles, two with Mrs. Sinclair and me (as co-coach), one with me as coach, and two with Mr. Lennox; while Mrs. Scott had nine conferencing sessions with me, which were mostly reflecting sessions and class observations (planning was embedded in the reflecting sessions). Bogdan and Biklen (1998) provide support for this idea of my meeting with some teachers more frequently than the others, because as they stated:

> some subjects [participants] are more willing to talk, have a greater experience in the setting, or are especially insightful about what goes on. These people become key informants and often you will talk with them, compared with other subjects [participants], a disproportionate amount of time" (p. 61).

Mrs. Scott's sharing sessions with me began on September 18 and continued until December 12. She experimented with the ideas and principles I mediated to her. Some of these were then shared with the other teachers.

I had three whole-group sharing sessions with the teachers. These sessions were held September 22, October 22, and December 5. The September 22 meeting served as the first meeting for teachers to share their personal translation of their experiences with one another and to give their over all reaction to the series of seminars. The December 5 meeting served as the last getting together of the group to share their impressions of their experiences with the process they were involved in. Only the October 22 session was of the nature that I had originally intended; the others emerged.

Table 2

Participants in the Sections of the Study

Participants	Role in school	Pre-PDP	PDP Phase I (June)	PDP Phase I (September)	PDP Phase II	Math Class Participation
DOMINION	**HIGH**					
Mr. Dyer	Principal				X	
Mrs. Scott	Dept. Head & Teacher	X	X	X	X	X
Mr. Lennox	Teacher	X	X	X	X	X
Mrs. Sinclair	Teacher	X	X	X	X	X
Mrs. Jacobson	Teacher	X	X	X	X	X
JERUSALEM	**HIGH**					
Mr. Sloley	Dept. Head & Teacher	X	X			
Mr. Newell	Teacher	X	X			
Mrs. George	Teacher	X	X			
Miss Zanti	Teacher	X	X			

Note. Table 2 provides an illustration of the institutions, the role of the participants, and their participation in the various sections of the study.

Participants

Participants in this study included teachers and their mathematics classes that the teachers chose to work with for the translation of their PDP seminar experiences. Pseudonyms have been used to replace the names of all participants and institutions for reasons of confidentiality. Profiles of the teachers and their involvement in the study are also provided. Data for these profiles were collected in initial individual interviews before the professional development seminars began.

Teachers

The eight mathematics teachers from both Jerusalem High and Dominion High participated during the first three days of the professional development seminars in June 1997 (see Table 2). However, during the summer, Mr. Sloley, the Head of the mathematics department of Jerusalem High and Mr. Newell left the school. No new teacher was employed immediately. The two remaining teachers assigned to teach all the mathematics classes decided that they could not add anything to their present teaching load; consequently, Jerusalem High chose to opt out of the remainder of the study. The contribution of the teachers from Jerusalem High was integral to my study because, in the collaborative setting, both sets of teachers pooled their ideas and interpretations of their experiences and generated the salient elements of the MLE during the first three days of the seminars. Only the four teachers from Dominion High participated in the last two days of the professional development seminars in September (See Table 2). The study exploring alternative approaches for the teaching of mathematics was therefore conducted in only one high school in Jamaica, Dominion High (see Table 2).

Participants from Jerusalem High School

Miss Vic Zanti. Miss Zanti was a trained secondary school teacher. Her areas of specialty were mathematics and music. She had taught mathematics and music for about nine years at the secondary school level prior to coming to Jerusalem High. She was a part-time teacher, at Jerusalem High for two years, teaching mathematics while pursuing a Bachelor's Degree in Secondary Education. She expressed interest in acquiring new techniques other than "book" knowledge to improve her teaching. Miss Zanti attended the June seminars during the period of her final examinations. She attended only the first two days of the seminars.

Mr. Jonah Newell. Mr. Newell was a part-time teacher at Jerusalem High and was a final year medical technology student with an Associate degree in Biological Science. He taught mathematics and physics at the Grades 10 and 11 levels for one year, preparing students for their final exiting external examinations. All students he prepared and who wrote the external examination in physics passed. (With reference to the pass rate nationally, the national pass rates in mathematics and physics were among Jamaica's lowest). Mr. Newell attended all three days of the June seminars.

Mrs. Georgina George. Mrs. George was a trained teacher holding a Bachelor's Degree in Secondary Education. She had been teaching for more than 25 years at Jerusalem High. Mrs. George, like Miss Zanti, is ~~also a~~ mathematics and music specialist. Music for all events and occasions at the school fell under her auspices. She was also the Chorister of one of the local churches in the community. Initially, Mrs. George did not volunteer information readily. Like Miss Zanti, she attended only the first two days of the June seminars.

Mr. Eric Slolely. Mr. Slolely had an Associate Degree in mathematics and had been teaching for over 15 years at the secondary school level. He taught mathematics and physics. He was the head of the mathematics department at Jerusalem High and was a member of various committees. At the time of the data collection, Mr. Sloley was working on his Bachelor of Science degree in mathematics. He did not attend the first day of the seminars but attended the last two days of the June seminars.

Mr. Horace Tomstone. Mr. Tomstone was the principal of Jerusalem High. He was a pastor of one of the local churches and taught religious education at Jerusalem High. Mr. Tomstone was reading towards his Ph.D. at one of the local universities. He had been principal of this high school for about nine years.

Participants from Dominion High

Mr. Charles Lennox. Mr. Lennox was a trained teacher for secondary school with a Diploma in the teaching of mathematics and general science. During his training, he did his teaching practice at Dominion High and, since his graduation in 1991, he has taught at this same school. Mr. Lennox not only taught general science and mathematics but also has been involved in several extra curricular activities in the school and in the community. He was the staff representative of the Inter-school Christian Fellowship group, played the piano and was a church pastor of one of the local churches in the community. Mr. Lennox stated that he enjoyed the use of the questioning technique in his teaching and admitted that it was the use of this technique that merited him the high grade he received on his student teaching practice. Mr. Lennox participated in all of the June and September seminars as well as all the activities of Phase II.

Mrs. Amanda Sinclair. Mrs. Sinclair was a trained teacher and one of the longest-serving teachers on the teaching staff at the Dominion High. She saw the growth of the student population from a mere 300 to the present enrollment of 750. Mrs. Sinclair had taught at Dominion High since 1976. She not only had been involved in providing the necessary academic development of students by teaching general science, mathematics, and physical education but also has been involved in coaching the net ball teams over the years, and leading them through several championships. She served on the Dominion High PTA executive council and was a board member. She also served as secretary of another institution in the community. Mrs. Sinclair participated in all seminars in Phase I and all the activities in Phase II.

Mrs. Peggy Jacobson. Mrs. Jacobson was a trained teacher, teaching for six years at the high-school level and at Dominion High for four years. She had been teaching English language, but recently had been asked to teach mathematics. She sponsored the drama club at Dominion High. My impression of Mrs. Jacobson during our first meeting in the interview session was that she did not volunteer information readily. Mrs. Jacobson attended only the first day of the June seminars; however, she attended all the September seminars and all activities in Phase II.

Mrs. Jean Scott. Mrs. Scott was the head of the mathematics department at Dominion High. She was a trained land surveyor but not a trained teacher. She had taught mathematics at Dominion High since 1989. Mrs. Scott also taught technical drawing, physics, and land surveying. In addition to her responsibilities as head of the mathematics department, she served on various committees at the school as well as other institutions in the community. My initial meeting with Mrs. Scott during the first interview session brought home the startling realization that she would be one of the chief agents for my data collection. Mrs. Scott did not attend the second day of the June seminars, but attended the September seminars and all activities in Phase II.

Mr. William Dyer. Mr. Dyer, a mathematics teacher, served the high school that is my *alma mata* for 14 years and was the vice principal for four years. He was an instructor for almost two years at one of the teachers' colleges where I met him. He was the new principal at Dominion High, entering his second year as principal when I entered the school setting for my data collection. Mr. Dyer was pursing a Master's Degree in mathematics education at one of the local universities.

Students

Background information on students. Coming from Grade 9, the Grade 10 students were streamed according to their career choice and ability. The streams were business, science, arts, and general studies. Students wrote a final examination in mathematics at the end of Grade 9 in June 1997. The score on this final examination at the grade nine level was the determining factor for those who would be prepared to sit the exiting external examination—the Caribbean Examination Council (CXC) examination. Those who scored above 40% were grouped for preparation for the general paper of this external examination over the two year period during Grades 10 and 11. Most of those who scored 40% and below were grouped according to sex to be taught basic mathematical concepts so they could function in their career choice.

Mrs. Scott was assigned the group of girls who scored 40% and below on the screening test. There were 21 students in this class. She was also assigned the science group but decided she would not separate those who scored 40% and below from the others but would keep them as a mixed group. This class consisted of 30 students. She also decided that she would expose both sets of students to the program I was offering. Mr. Lennox taught the 15 boys who scored 40% and below as well as the group that scored above 40% (24). Mrs. Sinclair taught the students from the General and Arts stream who scored above 40%. There were 27 students in this group. One of the new teachers to the department taught those from the business stream who scored 40% and below (14). Each class met for two sessions of mathematics each week. One session consisted of a single period of 35 minutes and the other was a double period of 70 minutes. All students at the Grade 10 level were scheduled for mathematics at the same time. This class arrangement did not allow me to work with only Grade 10 students as I had proposed for my study.

Mr. Lennox's Grade 8 students were entering their second year of high school coming from Grade 7. They were not streamed. There were 38 students in this class. Mrs. Jacobson's Grade 7 students were entering their first year of high school. There were 40 students in this class.

Coding techniques employed for students. A particular coding technique was utilized for each student in each class. Students' names were assigned a number. Because each class had been grouped according to career choice, students were coded according to career choice—Arts (A), Science (Sc), General Studies (GA). Grade 8 students were not streamed so (Sec) was used to represent Second Form or Grade 8. The date of the student's written reflection or interview was also included. For example "22ADec.5wr" identifies this student as a member of the Arts stream with data shared on December 5 in the form of a written reflection (interview would be "i"). Scripts numbered with "00" represented those individuals who did not include their names on their reflection scripts and so were numbered differently. This was encouraged to ensure students' free expressions.

Context of the Environment

Dominion High, one of six high schools within a one mile radius of one another, situated in a town in Jamaica, was founded early this century as a boys' boarding school. With its humble beginning in the early 1900s as an all-boys' preparatory school of fewer than 20 students, it was fully established as one of Jamaica's leading secondary schools in the 1960s.

In the mid 1970s, the school that had started out as an elite preparatory school for boys became a grant-aided, co-educational government secondary school. The school experienced growth not only in physical size but also in its student population, increasing to about 750. Classrooms originally built for 25 now accommodate an average of 40 students. New classroom blocks were being constructed to meet the demands of the student body at the time of data collection.

Historically, Dominion High gained a reputation for its high standards and has produced several of Jamaica's noted top scholars. In a survey covering four years in the late 1980s and the early 1990s, Dominion High ranked in the top 10 nationally for passes in the Caribbean Examination Council (CXC) Examinations for Spanish, geography, history, and business education at the national level. The history of passes in mathematics in the Caribbean Examination Council (CXC) Examinations has not brought much acclaim to the school; sometimes the pass rate was above the national average and other times it was not. With a pass rate below the national average in 1997, the principal and the head of the mathematics department reported that *"it was really devastating."* Hence, the need for certain practices to make a difference to the teaching and learning of mathematics was urgent. For this reason, I felt that the teachers and administrators were willing to accommodate ideas that were new and that they hoped would possibly make a difference in the teaching and learning of mathematics.

Data Collection

I hoped that the Professional Development Process (PDP) and the students' *mathematics learning experiences* together would provide a rich source for data. Semi-structured interviews, whole-group sharing sessions that included focus group interviews, cognitive coaching conferencing sessions and classroom observations, field notes, video taping, students' written reflections, and small group discourses were the modes of data collection employed in this study. The modes of data collection are arranged in three sets based on the time of data collection: The Pre-Professional Development Process (Pre-PDP), Professional Development Process (PDP)—Phase I, and Phase II, which consisted of the continuation of the Professional Development Process (PDP) and the *mathematics learning experiences* (MLE) (see Table 2).

Pre-Professional Development Process (Pre-PDP)

Prior to the Professional Development Process (PDP) seminars, all eight teachers from both schools were interviewed individually to identify the congruence between their needs and the objectives of this study. These semi-structured interviews were conducted at each of the schools between June 17 and 18, 1997. During the interviews, teachers were given the interview schedule so they could anticipate the next planned question. This helped me to conduct the interviews in the conversational style of everyday interaction (LeCompte & Preissle, 1993). This conversational style also aided me to respond naturally without the risk of losing rapport. This method is also supported by LeCompte & Preissel, who stated that the conversational style is "familiar and comfortable to all respondents" and "is most likely to elicit trust, confidence, and ease among respondents and is necessary for yielding elaborate, subtle, and valid data" (p. 179). The interviews were audio taped and lasted between approximately 30 minutes and two hours (see **Appendix A** for interview questions).

The Professional Development Process (PDP)—Phase I

Phase I of the Professional Development Process (PDP) consisted of the June and September seminars. Portions of the sharing sessions during the seminars were videotaped. These segments included teachers' reflecting on the seminar activities as well as a *cognitive coaching* cycle consisting of (a) a planning conference, (b) observation, and (c) a reflecting conference.

Phase II: The Continuation of PDP and the MLE

Phase II consisted of the continuation of the Professional Development Process (PDP) and the *mathematics learning experiences* (MLE) for students. It was comprised of whole group sharing sessions, unscheduled meetings with the principal, exiting interviews for teachers, students' mathematics learning discourses, students' written reflections, students' whole group sharing sessions, and teachers' *cognitive coaching* conferencing cycles, which included classroom observation.

Whole group sharing sessions. There were four whole group sharing sessions with teachers, three of which were video taped. The September 22 session lasted approximately two hours as teachers shared their overall impressions of the June and September seminars and the experience of their personal translation into the classroom.

The sessions took the form of semi-structured focus group interviews in which teachers responded to the questions they were given initially to guide their journal writing (see **Appendix C** for questions). The use of focus group interviewing as an additional line of action for the collection of group data is supported by Berg (1995). Interviewing reflects the collective notions shared and negotiated by the group. It also allowed me to observe the development of the process of interaction as this was of profound importance to the study (Berg). The semi-structured focus group interview (Berg) directed teachers to reflect on their classroom experiences. The informal atmosphere of the focus group interview structure encouraged teachers to speak freely about the particular topic of interest and importance to the group and to the researcher (Berg).

The October 22 professional development session was a full day of activities consisting of (a) a semi-structured group interview (see **Appendix D** for questions), (b) a content-oriented presentation, (c) an unguided whole group debriefing session, and (d) a cognitive coaching planning session. This PDP session included, in addition to the four teachers from Dominion High, the three newly appointed teachers to the mathematics department. These new teachers, invited to participate by the administration, were coached by one of the teachers.

The presentation by Mr. Dyer focused on one of the mathematical content areas that teachers had expressed their weakness in during the Pre-PDP interviews. The unguided focus group session, undertaken without any preconceived questions, focus questions, or guidelines, helped eliminate the researcher's perspective from the resulting data. Also, it allowed me to access the substantive content of the verbally expressed views, opinions, experiences, and attitudes. This technique is supported by Berg (1995). This professional development session also included for the new teachers a cognitive coaching session incorporating some of the mathematical concepts presented.

The whole group sharing session on December 5 lasted about half an hour. During this session, teachers shared their overall impressions of their PDP experiences with the principal.

Cognitive coaching conferencing sessions. The cognitive coaching conference sessions (i.e., the planning and reflecting sessions which took place throughout the term) were audio taped, while a sample of the lessons observed were videotaped. A sample of large-group sharing sessions, as well as students working in their groups, were videotaped during mathematics classes. I also took field notes whenever I was not videotaping. Observation of the mathematics lessons lasted for 30 minutes, a single period; or 60 minutes, a double period. Scheduled and unscheduled cognitive coaching sessions were audio taped. The teachers' cognitive coaching sessions lasted about fifteen minutes, except for initial coaching cycle during the seminars which lasted about one hour.

Unscheduled meetings with principal. I had seven unscheduled meetings with the principal, Mr. Dyer, throughout the term (September 11 & 18, November 12, 18, & 19, December 1 & 9). They lasted between fifteen and thirty minutes. I kept a log of these meetings and made notes of key issues raised. These written accounts which were made on the spot or written shortly after their occurrence are referred to as field notes by LeCompte and Preissle, (1993). These meetings also served the purpose of boundary spanning between administrator and teachers, administrator and researcher, and teachers and researcher as actions and motivations were explained (LeCompte & Preissle) and intents were made plain.

Exiting interviews with teachers. Each teacher was interviewed individually again at the end of the school term during the first or second week of December (December 4 & 9). These interview sessions lasted for approximately half an hour and were videotaped. An open-ended question was used to solicit their overall impression of the influence of the experiences and insights gained throughout the study. Teachers were asked: "What do you think the overall experience has done for you as an individual and as a teacher?" The responses generated further probes which provided elaborations and clarifications.

MLE: Students' Mathematics Learning Experiences

Students' *mathematics learning experiences* consisted of the discourses in the small groups, the whole-group sharing sessions, and their written reflections.

Students' mathematics learning discourses. During the initial stages of the *mathematics learning experiences*, students were given micro cassette recorders to record the discourses which took place in their small groups. Four micro-cassette recorders were rotated among students' learning-groups during the mathematics lessons. One purpose was for the teachers and me to listen to students' discourses to identify how effective the assigned roles were in effecting the desired discourse in each learning-group during the solution of mathematics problems.

Students' written reflections. Specific questions were given to students to channel their writing about their *mathematics learning experiences* (See **Appendix E** for questions). Mrs. Scott's and Mrs. Sinclair's classes did written reflections after they were introduced to the salient elements of the learning experiences. There were, at most, four written reflections for any one class. Mr. Lennox's and Mrs. Jacobson's classes did not do a written reflection as they were officially out of the study before they were asked to give their reflections on their experiences.

Students' whole group sharing sessions. Three of the four teachers' classes were interviewed in the form of a whole-group sharing session. These whole-group sharing sessions were led by the regular classroom teacher at the end of the school term in December. Two open-ended questions were used to solicit their overall impressions of the influence of their mathematics learning experiences. Students were asked: (a) What influence did the MLE have on you as a student? and (b) How did the roles you played in your groups impact on your learning of mathematics? The responses generated further probes which provided elaborations and clarifications. These sessions lasted for 20 to 30 minutes and were videotaped.

The Role of the Researcher

Being granted a Canadian International Development Agency (CIDA) scholarship as part of a joint project between the University of Alberta and the Joint Board of Teacher Education at the University of the West Indies (UWI), for the development of teacher education (pre-service and in-service) in Jamaica, I was afforded the privilege of reading towards a Ph.D. With mathematics education as my main area, and being concerned with the realities of the national pass rates by exiting high-school students, the lack of resources, and the overcrowded classrooms, I decided to take up the challenge of seeking a solution to the problem of low pass rates in mathematics in a micro way. If this problem were to be addressed nationally at some future time, I needed to devise an approach that could be utilized by every student of every economic strata at the secondary school level. Therefore, devising a plan which would allow each student to maximize his or her mathematical potential became my problem.

I then set out to conceptualize a Mathematics Learning Program (MLP) that might maximize each individual's ability within the regular mathematics classroom. I decided against the easy route of going to a high school in Jamaica and requesting a class to teach for one school term to have students share the principles I had put together. Instead, I decided to incorporate a set of teachers in the program through a professional development series in which I would invite them to participate in an experience similar to the one which I had conceptualized for the students' mathematics learning experiences. Thus, through their professional development experience, they would have to generate the same or a similar learning process to the one I had conceptualized initially for the students.

I knew some of the principals of the high schools, but I decided on two schools within close proximity of each other. This was in harmony with the initial conceptualization of the study where I conceived of both schools' participating during the school term to allow me easy access to travel from one school to another on the same day and to observe particular classes and work with the teachers. This close proximity would also allow teachers to be able to travel between schools for sharing sessions.

I knew the principal and teachers of Jerusalem High very well; however, I had just a brief acquaintance with the principal of Dominion High, and I did not know any teacher in the school. Even though I did not know the second principal very well, I was made aware of a few things about him that were common to my own experience.

My role during data collection— Participant-Researcher. To establish my role as a participant-researcher, I balanced my observation and participation according to what was taking place (LeCompte & Preissle, 1993) during each phase of data collection. It was imperative that I developed a rapport through discourse with each participant to learn of his or her needs in the teaching and learning situation and to envision the degree to which my proposed program for professional development would address their expressed needs. As an interviewer, I sought to initiate the development of rapport during the Pre-PDP stage. A further enhancement of rapport through discourse took place when participants became involved in an experience with the use of the *tools* for *Cognitive Coaching* and *Discourses* during the five days of seminars in Phase I. This accorded with LeCompte and Preissle's statement that the issue of language fluency is critical because, even though the researcher was working within her culture and language, it was imperative that elegant linguistic tools (Costa & Garmston, 1994) were employed in our discourses so that common meanings could be ensured for actions as well as making intents clear for that which was stated.

My role as participant-researcher allowed me the ongoing opportunity to contribute and to learn along with the teachers and students during Phase II. My observations and participation in the classroom occurred as part of the cognitive coaching cycles and was formative in purpose. My role as coach or co-coach was consultative because the coaching was not reciprocated. I also had the opportunity to interact with students in their learning groups and with the teachers as I shared insights with them during mathematics lessons. I interacted with teachers and their students during at least 37 lessons (See Table 3), which lasted for either 30 or 60 minutes. My role in being able to communicate within and across teacher-groups and student-groups was critical to the success of this study. This role, LeCompte and Preissle (1993) termed "boundary spanning" (p. 103), because of the employment of skills in communication embedded in discourse as well as my understanding of some of the nuances of the groups involved in the study.

The students seemed free to solicit my opinions on substantive issues. I had the opportunity to engage in acts of mediation to pace and lead, as they generated solution paths for mathematics problems. I made on-going observations, videotaped class activities, recorded field notes of what took place into the classroom among and within groups where possible, and noted the teachers' and students' discourses and interactions in the mathematics learning environment. As recommended by Merriam (1988) and Rudestam and Newton (1992), I scratched notes to myself. These notes I classified as field notes (LeCompte and Preissle, 1993). I recorded some of what I saw and what I was learning in the setting and documented some of the experiences as they came about. Doing so was crucial to my data collection as it provided details about the events observed, including specifics regarding dates, times, and settings.

Table 3

Observation of and Participation in Teachers' Classes

Teacher	Date	Class	Duration (min.)
Mr. Lennox	September 29 (Mon)	Grade 8	35 minutes
	September 30 (Tues)	Grade 8	70 minutes
	October 1 (Wed)	Grade 8	35 minutes
	October 2 (Thur)	Grade 8	70 minutes
	October 6 (Mon)	Grade 8	35 minutes
	Midterm exams, break, writing exams		
	November 4 (Tues)	Grade 8	35 minutes
	(Nov. 5 A student died)	no class	
Mrs. Sinclair	September 29 (Mon)	Grade 11	35 minutes
	October 3 (Fri)	Grade 11,	35 minutes
	October 9 (Thur)	Grade 10	70 minutes
	October 15 (Wed)	Grade 10	35 minutes
	October 16 (Thur)	Grade 10	70 minutes
	Midterm exams, break, writing exams		
	November 4 (Tues)	Grade 10	35 minutes
	(Nov. 5 A student died)	Grade 10	70 minutes
	November 6 (Thur)	Grade 10	70 minutes
	November 13 (Thur)	Grade 10	70 minutes
	November 25 (Tues)	Grade 10	35 minutes
	December 4		
Mrs. Jacobson	October 3 (Fri)	Grade 7	35 minutes
	October 7 (Tues)	Grade 7	70 minutes
	October 14 (Tues)	Grade 7	70 minutes
	October 15 (Wed)	Grade 7	35 minutes
	Midterm exams, break writing exams		
	November 4 (Tues)	Grade 7	70 minutes
	(Nov. 5 A student died)	no class	
	November 11 (Tues)	Grade 7	70 minutes
	November 18 (Tues)	Grade 7	70 minutes

Table 3 contd.

Mrs. Scott	September 29 (Mon)	Grade 10 -4 Arts	35 minutes
	October 2 (Thur)	Grade 10- 4 Arts	70 minutes
	October 6 (Mon)	Grade 10- 4 Arts	35 minutes
	October 13 (Mon)	Grade 10 - 4 Arts	35 minutes
	Midterm exams, break		
	November 3 (Mon)	Grade 10 - 4 Arts	35 minutes
	November 11 (Tues)	Grade 10 - 4 Science	35 minutes
	November 12 (Wed)	Grade 10- 4 Arts, 4 Science	35 minutes
	November 20 (Thur)	Grade 10 - 4 Arts	70 minutes
	November 24 (Mon)	Grade 10- 4 Arts,	35 minutes
	December 1 (Mom)	Grade 10 - 4 Arts	35 minutes
	December 2 (Tues)	Grade 10 - 4 Sc	35 minutes
	December 4 (Thur)	Grade 10 - 4 Arts	70 minutes
	December 5 (Fri)	Grade 10 - 4 Sc	70 minutes
	December 12 (Fri)	Grade 10 - 4 Sc	70 minutes

Note. This table presents the dates, times, and teachers' mathematics classes that I, as participant-researcher, visited and participated in during the school term, September to December 1997.

The Case Study Method

The case study as a formal, comprehensive research strategy (Yin, 1994) was also employed as an integral part of this research design. The case study is a detailed examination of a setting, a single subject, a single depository of documents, or a particular event (Bogdan & Bilkin, 1998). According to Yin (1994), it "is an empirical inquiry that investigates a contemporary phenomenon within its real-life context" (p.13). Therefore, the case study method was employed to examine in detail the setting within the "real-life" context of the teachers' and students' learning experiences as they accommodated this alternative approach.

Case studies, Yin (1994) affirms, may be used for explanatory purposes while "how" and "what" questions are explored. As I addressed my "how" and "what" research questions for the analysis of the data gathered, this explanatory qualitative research study—"a qualitatively new form"— (Capra, 1996, p. 65) emerged. It seeks to bring forth the dynamic relationships which existed between and among the components of teachers' PDP experiences and students' *mathematics learning experiences* (MLE). Therefore, I utilized narrative accounts from various modes of data collection. These narrative accounts were melded with descriptive data. According to Yin (1994), "Some of the best and most famous case studies have been both descriptive and explanatory" (p. 3). So the multiple-embedded cases (Yin) that the teachers and their classes facilitated were utilized to provide the descriptive and explanatory aspects of the study.

When researchers study two or more subjects, settings, or depositories of data, they are doing multi-case studies (Bogdan & Biklen, 1998). Yin (1994) suggests that researchers consider multiple cases as they would consider multiple experiments in terms of following a "'replication' logic" (Yin, p. 45). The four teachers and their classes served as the multiple-embedded cases for this study, so that the uniqueness, commonalties, and differences across cases could be observed. The embeddedness of a case, Yin observes, occurs when the approach is not holistic, but when attention is given to a sub-unit or sub-units within each case. For example, the individual students within the classes, along with the teachers provided the embeddedness of each case.

The multiple-embedded cases provided a range of perspectives for *internal sampling* as particular concepts were utilized across cases in the teaching and learning settings. Bogdan and Biklen (1998) cautioned that, "one should not approach internal sampling with the idea that you have to spend the same amount of time with everyone"(p. 61). Because some participants might be "more willing to talk, have greater experience in the setting, or are especially insightful in what goes on" (Bogdan & Biklen, p. 61), these individuals become key informants and the researcher will talk with them more often than with other participants. Also, if the focus is a particular class, the researcher may want to sample widely from different times of day or days of the week. According to Bogdan and Biklen, the decisions that qualitative researchers make relating to the choice of informants, the allocation of time, and the amount of time the researcher should set aside for a case study are always made in the context of the study. This was true with respect to one of my cases, because while in the setting, I realized that this teacher and her classes could become key informants for my study; therefore, we spent a lot of time together, and I visited her classes more regularly than those of the others.

A case study is considered one of the best means of reporting, according to Guba and Lincoln (as cited in Merriam, 1988), because "it provides 'thick description', is holistic and lifelike, simplifies [the] data to be considered by the reader, illuminates meanings, and can communicate tacit knowledge" (p. 28). Journeying with each teacher from their initiation with the learning experiences to their accommodation satisfies this criterion because I provided details of these experiences to clarify and explain the intricacies involved across cases.

The case study strategy, according to Merriam (1988), can also be used to explore situations in which an intervention being evaluated does not have a clear single set of outcomes. Hence, this strategy was also employed as part of the data analysis procedures. So while some case studies are purely descriptive, others are a combination of description and interpretation. This study is an example of the latter.

The Data Analysis Procedure

This explanatory qualitative study was aimed at interpreting actions and perspectives of the participants involved and examining the transformation of the learning communities into collaborative, self-reflective communities of inquiry. The insights obtained from this qualitative research not only added texture to the analysis but also demonstrated meanings and understandings about the phenomena that would otherwise have been unidentified (Berg, 1995). The focus on analysis was on substance to elicit meaning from the data (LeCompte & Preissle, 1993).

To begin the process of data analysis, I re-examined my research questions that shaped my initial inquiry and that subsequently shaped and informed my examination of massive amounts of data (Yin, 1994). Data from individual interviews, students' written reflections, students' mathematics learning discourses, field notes, cognitive coaching conferences, and whole-group sharing sessions, which included semi-structured interviews filed according to date and case were examined to generate and verify the explanations in this comprehensive research design (LeCompte & Preissel, 1993).

Everything was considered to have potential importance. Because I sought to examine the complexity of this study within the naturally occurring contexts, all modes of data collection were considered noteworthy (LeCompte & Preissle).

My next step was to read the data, checking for completeness and to reacquaint myself with what had transpired. As I read, I made notes and observations in the margins of the transcripts; these notes isolated the aspects of the data that were most striking and important to me. The guidelines used for making these notes were intuitive. My personal background and the constructs made explicit by participants also served as guidelines for making these notes (LeCompte & Preissel, 1993). The notes made while reading the data were the beginning of the stage of organizing, abstracting, and synthesizing. These notes served to inform my primitive outline or system of classification into which the data was sorted initially. This method is supported by LeCompte and Preissle, as this outline began my search for regularities. These ideas generated from the notes were then transformed into categories into which subsequent bits of data were sorted. These categories emerged from the data. Various colored highlighters were used to differentiate these categories of data initially. Then I used my computer to "cut and paste" information according to the categories.

The analytic procedure employed in constructing the categories that were discovered from the data emerged as a systematic application of the process of theorizing outlined by LeCompte and Preissel (1993). Core properties of categories were discovered by identifying how bits of data were alike and how they differed. By putting together those which were alike and went together, I separated them from those that were different. The aspects of similarities and differences formed the basis for differentiating, sorting, and defining each category. Hence, the open coding procedure involved in axial coding was utilized (Berg, 1995). Therefore, while coding a particular quote or incident for a category, I compared it with previous quotes and incidents within the same group and also different groups within the same category (Glaser & Strauss, 1967). All data were coded "minutely" as scripts were carefully read to determine the concepts and categories that fit the data. Thus, according to Glaser and Strauss, theory is generated by taking apart the story within the data and integrating categories and their properties. As categories emerged, they could be considered as two types; those that I constructed and those that were "abstracted from the language of the research situation" (Glaser & Strauss, p.107).

I did not attempt to fit data into predetermined categories (Dall'Alba, et al., 1989), but my written notes often suggested more than one category into which quotes and incidents could fit (Glaser & Strauss, 1967). Even though the identification of categories had been informed consciously or unconsciously by the constructs in the conceptual framework, analysis was not limited to such, but other constructs which were made explicit by the data emerged. Inductive or emerging categories were developed to "link or ground" these categories to the open-coded data (Berg, 1995, p. 180). Therefore, as the categories were established, data were sorted, organized, and aggregated into the relevant groups through the identification of properties or attributes that the data units shared (Glaser & Strauss, 1967).

Next, I tried to fit bits of data together to form a coherent whole. I also tried to use representative data; that is, data that reflected the population from which they were drawn (Booth, Colomb, & Williams, 1995). As bits of data formed a coherent whole, I deduced the main point or general thesis, thus formulating a claim which the bits of data as evidence served to substantiate (Booth et al.). In many instances, each claim with its representative data as evidence served as a sub-claim to a major claim. Each main claim was divided into groups of smaller arguments, and each in turn was structured as a sub-claim with its own supporting evidence (Booth et al.). This procedure is supported by LeCompte and Preissle (1993), who state that properties shared among data units can be used to order sub-categories or to create a categorized hierarchy generating themes. After I established relevant categories within which data were organized and sorted, a complex, whole phenomenon emerged, according to LeCompte and Preissle.

Teachers and their classes served as cases. The analysis of data for each case began with the personal translation of the teachers' PDP experiences in the classroom. Then the cognitive coaching experiences of each teacher and the students' perspectives on the principles involved in the approach that they were exposed to were included. The salient aspects typical but essential for the accommodation and the development of an alternative approach were also included; this revealed how similar or how different each case was. Each teacher's "journey" was therefore mapped by a sequence of events that led to the accommodation of the *mathematics learning experiences* in the classroom.

Justification for the Methodological Approach

The qualitative approach, applied pedagogically, according to Bogdan and Biklen (1998), is a research method that seeks to describe and analyze complex experiences. The modes of data collection employed compel the researcher to "listen well, question closely, and observe details to bring disparate and often unsought points of view out in the open" (Bogdan & Biklen, p. 238). The purpose of utilizing various data gathering techniques through an eclectic approach was to learn respondents' perspectives. The semi-structured interviews employed provided an opportunity to obtain comparable data across respondents, while focus group interviews encouraged a dynamic group dialogue in a situation that encouraged participants to talk about the subject of interest (Bogdan & Biklen).

The cognitive coaching conferencing cycles as a data gathering technique served to promote certain actions and served as a means of reflection on the actions. Thus, a relational experience emerged. According to Linder and Erickson (1989), relational quality reflects the view that a person's experiences, intentions, and purposes are strongly influenced by the situation he or she is in. This process provided an understanding of the links between the displayed behavior and the internal responses that served as the basis of metacognition (Vygotsky, 1978). The participant-researcher data gathering technique employed allowed me, as researcher, to internalize the research goals while collecting data and shaped my degree of participation in the research setting.

The methodological approach may also allow other researchers to explore a similar phenomenon, while the interpretive mode of inquiry employed may aid in the understanding of the nature of this phenomenon. As a result, the case study, as one research strategy, was employed because I wanted to include contextual conditions which I believe were highly pertinent to this study: Also it is a comprehensive research strategy comprising an all encompassing method (Yin, 1994).

Although the end product of a case study can be primarily descriptive, interpretative, or evaluative, innovative programs, according to Merriam (1988), often focus on descriptive aspects since such studies often form a data base for theory building and future comparison. I gathered as much information about this venture as possible with the intent of interpreting the phenomenon. Rather than just describing, I used the data to develop categories that represented the conceptualization of the nature of the approach used in the development of this phenomenon. The model of analysis embedded in this approach is inductive. Also, because greater amount of analysis was involved, it probably could be termed "analytical" (Merriam, p. 28). Analytical case studies, according to Merriam, are differentiated from straightforward descriptive studies because of their complexity, depth, and theoretical orientation.

The intent of the analysis was to provide an understanding of what individuals thought about. Therefore, I focused on conceptions in this research and not people (Linder & Erickson, 1989). Since the same categories of description may appear for different situations, they were stable and transferable between situations (Marton, 1981). This served as a way to order individuals' thoughts systematically into the ways in which they interpreted aspects of their reality that were socially significant and that were shared by members of the group (Marton). Thus, a developmental viewpoint of the process analysis (Vygotsky, 1978) is presented.

The "two parts of the same process" explicitly involved in this methodology are the emergence of theory and the doing of research (Strauss & Corbin, 1994, p. 273). The interpretation of the perspectives and the discourses which emerged during the multiple modes of data collection, along with the voices of the participants (Strauss & Corbin), were accommodated within the multiple-embedded cases (Yin, 1994). Interpretations were also sought for an understanding of the actions of the individuals involved (Strauss & Corbin, 1994) as meanings were explored during discourses to understand the context and conditions of the expressed ideas. Thus, this explanatory study provides the content for the development of theory that is aimed at interpreting the actions and the perspectives of the participants involved. This study is also aimed at transforming learning communities into collaborative, self-reflective communities of inquiry.

Strategies for Trustworthiness

Strategies for trustworthiness which are considered include credibility, confirmability, transferability, and dependability, as suggested by Guba (1981).

Credibility

How one establishes "truth" in the findings from participants' responses and the context in which the inquiry took place addresses the question of credibility (Guba, 1981). Credibility is also addressed when findings capture what really existed or when researchers really observe and measure what they thought they were measuring (Merriam, 1988).

According to Janesick (1994), validity in qualitative research has to do with whether or not a given description matches a particular explanation. Interviewing as one of the major methods exposes one to constant questioning and re-evaluation during all phases of the research activity. Since I was interested in documenting the nature of the experiences as the experiences came about, it was important to understand the perspectives of both teachers and students and to present a holistic interpretation of what happened (Merriam, 1988). Therefore, the context, the content, and the interactive structure (Riley, 1985) of the discourses that were generated were important for me to interpret what was said. Validity of ideas during discourses are consensually validated through the probes involved in the communicative process. The strategies, as outlined by Guba (1981), used to enhance the truth value of this study are provided below.

Prolonged and consistent engagement at site. My prolonged engagement of approximately four months allowed me the opportunity to become part of the teaching-learning environment. Therefore, the measure of reactivity to my presence was decreased with time (Berg, 1995). Even though I did not know the teachers from Dominion High prior to my study, after my initial individual interview session, they expressed their comfort with me when sharing their concerns. This initial experience, along with subsequent ones, helped me feel satisfied that my presence did not constitute a threat (Guba, 1981).

Persistent observation and interaction. Becoming a part of the school's culture and the classroom milieu through extended interaction and observations led me to understand the essential characteristics of the PDP and the MLE.

Peer debriefing. The level of communication that existed between the participants and me in the PDP provided me with opportunities to explore insights (Guba, 1981). I was able to detach myself at times from the site to seek out and interact with my dissertation Supervisor through electronic mail. The confirmation of suggestions I shared with my Supervisor provided viable alternatives which could have been explored if needed. I was also able to interact with the principal on a regular basis, getting his perspective about what was happening to the mathematics teachers and their classes. This was done as the principal was making observations and drawing conclusions from the teachers' conversations with him.

Collection of referential adequacy materials. Video-tapes and audio recordings were obtained for most situations from which data had been drawn. These provided verification of findings and interpretation from different perspectives. Therefore, the assertions drawn can be tested by reference to these archives (Guba, 1981).

Member feedback. Member checks, according to Guba (1981), involve a situation "whereby data and interpretation are continuously tested as they are derived with members" of the group from which data were collected (p. 85). This was not done in the way it was recommended as transcription of audio-tapes and video tapes did not take place until after the period of my data collection. However, participants, including the students videotaped during their interview sessions, were given the opportunity to watch videos and to give feedback if they changed their views or if they thought any particular incident would be misinterpreted. Students also listened to themselves as they thought through the solutions of problems during their group interaction in the classroom. Participants watched the videos to ensure that what they said candidly on camera was what they intended. Even though at least one of each teacher's class was video taped, only one teacher, Mrs. Scott, watched the taped class and provided feedback concerning her interpretation of what she saw.

Paraphrasing and questions which served to generate further probes were employed to check the veracity of interpretation during the interactive discourses which included cognitive coaching conferences. After watching and listening to themselves, teachers did not suggest changes or caution when dealing with any issue. Instead, they cited incidents in previous discourses and used them as referential points for elaborations and reinforcements during subsequent sessions. Including the process involved in member feedback, according to Guba (1981), "is the single most important action inquirers can take, for it goes to the heart of the credibility criterion" (p. 85).

Establishing structural corroboration. The interpretations of data which were similar across cases and phases of the PDP and the MLE, as well as interpretations which were different, are presented to ensure that there were "no internal conflicts or contradictions" (Guba, 1981, p. 85). Each case—that is, each teacher and his or her class(es)—was unique. Although there were similarities across cases, each one approached the translation of his or her experiences differently. Therefore, the interpretations of the differences, from my perspective, are also provided. Interpretations of negative cases or those that might have differed from an accepted norm are also presented because these cases might provide one means for assessing internal validity (Guba).

Triangulation I. Multiple modes of data collection were utilized to corroborate findings. Interviews, observation, field notes, written reflections, and cognitive coaching conferences were chosen as sources for data collection. These modes of data collection served the purpose of verifying data from different perspectives during the various phases of the study. These data sources also corroborated similar concepts and allowed for the development of converging lines of interpretation (Yin, 1994). This corroboration added scope and depth to the study (Creswell, 1994) and allowed for the test of the credibility of findings (Guba, 1981; Merriam, 1988). The multiple cases the teachers and their classes facilitated also allowed for triangulation (Yin, 1994). Guba (1981) suggested that no item of information should be accepted unless verified from at least two sources. However, depending on the differences or similarities which existed in various situations, the uniqueness of cases allowed for similar as well as contrasting information, themes, or findings (Yin, 1994).

Confirmability

Triangulation II. Triangulation is key to credibility and confirmability as it relates to the cross-checking and interpretation of data from at least two perspectives and/or modes of data collection. The multiple-embedded cases also served the purpose of triangulation. Veracity of data can also be obtained in many instances from the paraphrasing and the probes that were generated by participants at various times during the phases of data collection. This method of verification might also serve the same purpose as cross examination.

Transferability

Transferability or external validity refers to the extent to which the findings of a study can be applied to other situations, or how transferable the results of the research are to other contexts (Merriam, 1988; Guba, 1981). The schools that participated in this study were chosen because of accessibility, convenience and low pass rates in mathematics and because I knew the principals. The characteristics of the multiple-cases presented may allow for comparison with other contexts to which transfer may be contemplated. Therefore, the range of information covered may be typical to similar contexts. Salient contextual factors typical to this study are also documented as part of the data collection process so that judgments may be made about the "fittingness" of the context to other possible contexts (Guba, 1981).

Dependability

Dependability refers to the extent to which one's findings can be replicated (Merriam, 1988) and whether consistent procedures produced stable and meaningful results (Guba, 1981). In most instances during class observations, whole-group and individual interview sessions, field notes were made; videotaping or audio-taping was also done. These modes of data collection complemented one another as videotapes or audio-tapes provided details which were not recorded in field notes. Also, field notes supplied details that the video tapes did not provide. The same was done for the audio-taping of cognitive coaching conferences, where field notes provided details that conferencing did not capture. The weaknesses of one mode of data collection were compensated for by the strengths of the other because the "multiple-operations inquiry" modes were utilized in tandem (Guba, 1981, p.86). I am confident that, should another investigator follow exactly the same data collection procedures described here, it is probable that, given the necessary conditions, similar findings and conclusions may be derived (Yin, 1994).

Delimitations

The delimitations of this study are the limitations which I deliberately imposed on the research design (Rudestam & Newton, 1992). This study was delimited to a number of factors which included the following:

1. Data were collected from two of nine high schools within a town in Jamaica. The two high schools were invited to participate in this study because I was acquainted with the principals and because the distance between the schools was approximately one mile, allowing for easy access. The schools had low pass rate in mathematics at the external examination level.
2. The principal, the teachers from the mathematics department of each high school, and the mathematics class(es) teachers chose to work with were volunteers who participated in this study.
3. The constructs dealt with in the conceptual framework of this study delimited the conceptual ideas that I entered the research setting with.
4. The period of time spent in the research setting served as a delimitation. This study started with individual interview sessions, a three-day seminar series in June, and a two-day seminar series in September. The seminars were considered Phase I of the PDP. Phase II lasted for one school term, from September to December 1997.

5. This study focused on perceptions of participants based on their experiences while participating in the study. Therefore, causal inferences which might have been drawn were limited to the non-experimental conditions employed in this study, the inadequacies of the method employed, and the weakness of the data collected.

Limitations

The limitations of this research design refer to the restrictions in the study over which I had no control (Rudestam & Newton, 1992).

1. The schools selected were from different religious persuasions. However, there was uniformity in the curriculum-guide that was used across schools.
2. Findings are limited to information obtained through analysis of perceptual data from the students' and teachers' points of view.
3. Findings are also situational, but might help to identify other cases to which results can be transferred if the participants were provided with a similar experience. Granted the commonality of certain characteristics of these cases to the general populace, the possibility exists for replication of this study (Creswell, 1994).
4. The method used included data which were self-reporting. This technique, according to Ericsson and Simon (1980), is subject to individuals' response according to what is socially desired and, as a result, may distort what participants really experienced. This possibility, along with other threats to consistency and credibility, has been taken into consideration.
5. This study is also limited by the fact that one school withdrew after the first set of seminars in June.

Assumptions

The assumptions embedded in the theoretical and methodological stances which I have adopted for this study were that:

1. Principals would be accommodating so as to make possible time-table adjustments in order to facilitate the demands of the PDP and the MLE.
2. The administration of the school would allow me to work with some students in the upper school at the Grade 10 level.

3. Teachers would want to entertain the possibility of a change in their method of teaching.
4. All teachers in the mathematics department of each school would volunteer to participate in this study.
5. If the needs of the teachers were aligned with the objectives of the study, participants would "buy in" and embrace the principles embedded in the alternative approach that my study advocated.

Legal Considerations

The permission to conduct this study in the two schools was acquired from the two school boards through the principals. The teachers' and students' voluntary participation was solicited after they were informed about the objectives of the research and the degree of their involvement.

The administration of the school gave consent as the custodians of the students in the teaching-learning situations for the videotaping and audio-taping of student interviews and of the class sessions. If and when research is conducted in these schools, it is not the usual practice for researchers to inform the teachers from whom they are soliciting ideas except when a questionnaire was utilized. Consequently, the administration did not honor the request for letters to be sent out requesting parents' permission for their child(ren) to participate in my study. The administration explained that many questions would be raised by parents with regard to the credibility of the administration in making decisions concerning what was best for their children's learning. Research activity is not a common occurrence in the school system in Jamaica.

Even though parental consent was not solicited, each teacher introduced me to each of his or her classes and explained my role and my purpose in the classroom. Each students' active participation was solicited orally.

Ethical Considerations

The research for this study has observed the ethical guidelines as set out by the Ethics Review Board of the University of Alberta. The study was approved and permission to conduct this research was granted by the Ethics Committee of the Department of Elementary Education.

Participants were informed about the nature of their involvement and the nature of this research, after which their voluntary involvement was solicited. I accepted the principle that my attempt to advance knowledge would not interfere with my obligation to protect participants. As teachers and students engaged in the cognitive coaching experience and explored alternative strategies in the teaching and learning context, a minimal degree of risk was posed to the teachers and students involved in this study. No physical or mental harm to participants was anticipated.

Participants were advised that they could withdraw at any time if they wished to do so. Teachers were also asked to sign consent forms **(Appendix F)**. The consent forms guaranteed confidentiality and the opportunity to withdraw at any point without penalty. Confidentiality was ensured by the use of pseudonyms; therefore, the institutions', teachers', and students' identities were concealed. The opinions and information provided in the individual interview sessions for each participant were treated with confidentiality.

Literature related to the elements of my conceptual framework and the methods employed was examined to guide my study. I believe I have a sufficient knowledge-base about the recent relevant literature, the procedure, the direct experience with the techniques involved as well as the risks, and the possible uses to which results of this study may be put. I am not aware of any research that has been done involving all elements of my proposed research; neither has any of its kind been conducted in Jamaica (no available documentation). For an ethical dilemma which arose, wherein details relating to my research were being solicited by another researcher at the school, I solicited the advice of my Supervisory Committee through electronic mail.

The Explanatory Qualitative Methodology For Coaching Discourses

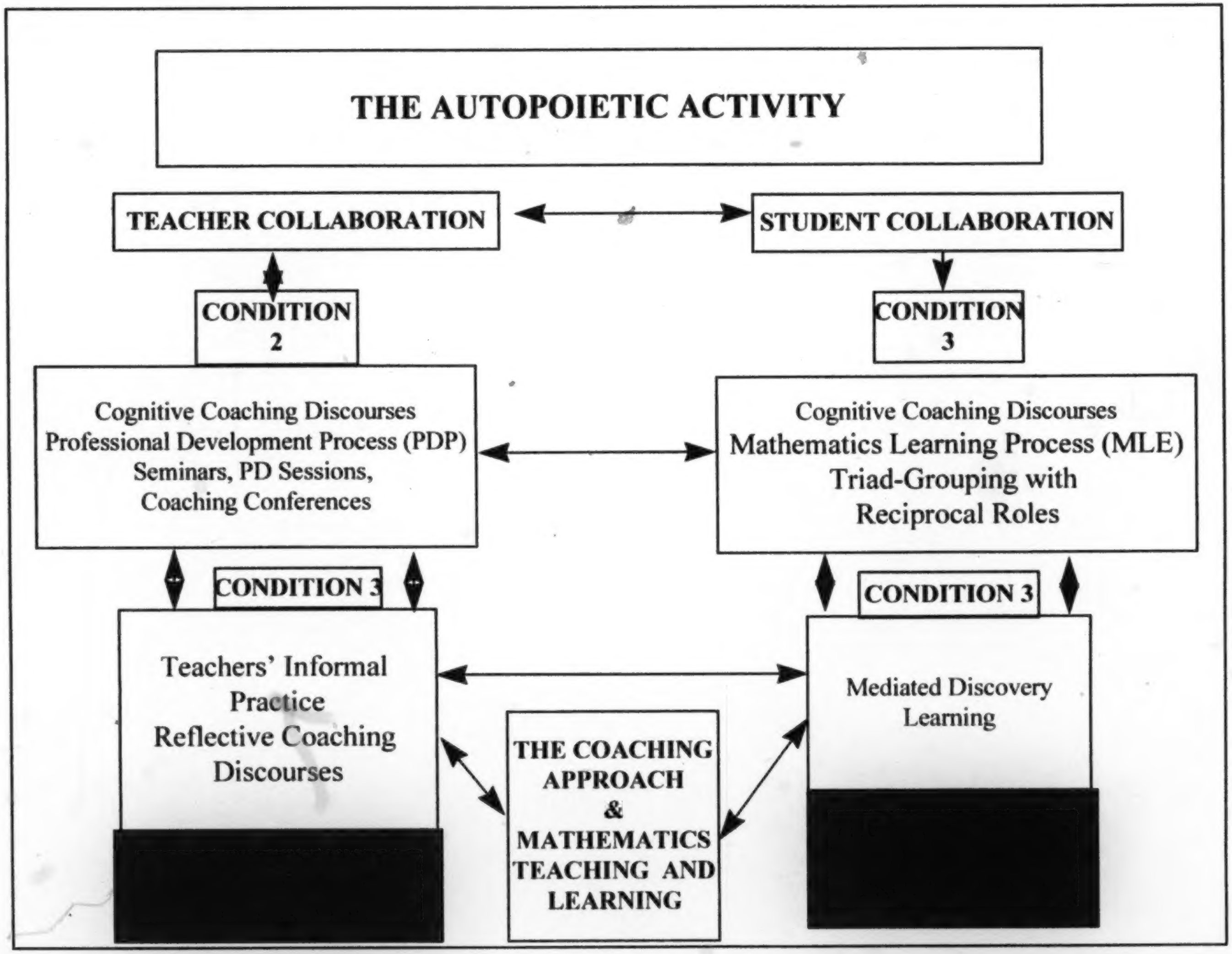
"An explanation," according to Maturana and Varela (1998), "is always a proposition that reformulates or recreates the observations of a phenomenon in a system of concepts acceptable to a group of people who share a criterion of validation" (p.28). To elucidate the explanatory qualitative form taken to analyze the data gathered in this study, I have chosen the use of Maturana and Varela's four conditions for the proposition of an empirical explanation to bring forth a theory.

The simplest form of scientific theories, according to LeCompte and Preissle (1993), is substantive theories. These "are interrelated propositions or concepts which create explanations for the existence of phenomena lodged in particular aspects of … settings . . . . They are restricted to features of . . . settings which can be identified concretely" and are "developed to explain formal learning and teaching in school settings" and "are substantive in nature." Also, they "include a careful explication of how the components, categories, or concepts are connected or interrelated" (LeCompte & Preissle, p. 134). Thus, the proposed conditions for an empirical explanation which do not necessarily fall in the order given but which might overlap are:

1. Describing the phenomenon or phenomena to be explained in a way acceptable to a body of observers.
2. Proposing a conceptual system capable of generating the phenomenon to be explained in a way acceptable to a body of observers.
3. Obtaining from (2) other phenomena not explicitly considered in that proposition, as also describing its conditions for observation by a body of observers.
4. Observing these other phenomena obtained from (2) (Maturana & Varela, 1998, p. 28).

This approach is concerned not only with the individual components but also with the effects arising from the mutual interactions of the components and therefore to understand the conditions specified above, it is necessary to draw on the conceptual framework of "autopoiesis" (Maturana & Varela, 1998, p. 89) to generate an explanation for the systemic thinking for this approach (see Figure II).

Figure II. The Autopoietic Activity



Autopoiesis, Capra (1996) stated, is a term coined by Maturana and Varela. "Auto" means "self," referring to the autonomous self-organizing systems, while "poiesis," which shares the Greek root for the same word as "poetry," means "making." Therefore, "autopoiesis means self-making" (Capra, p. 97). Self-making, according to Capra, "means that all components, including those of the boundary, are produced by processes within the network" (p. 208). To illustrate the pattern of the organization of a network of relationships within a boundary, the biological example of the living cell is used as a model of the simplest autopoietic system. This system is characterized by the non-linear interconnectedness (circularity) of the system's components, which results in feedback loops. This circularity must be produced and maintained by the system. Therefore, each component's function "is to help to produce and transform other components while maintaining the overall circularity of the network" (Capra, p.96).

New relationships are continually being created within the network, according to Capra (1996); hence, given the right conditions, the constant interactions of the metabolic processes within the cell are always generating new components, each with its specified functions. It is therefore necessary to have a constant flow of energy and matter throughout the system for this to take place (Capra). Some of these components produce a boundary which serves as a limit to the network's transformations. This boundary "not only limits the extension of the transformation network that produced its own components but also participates in this network" (Maturana & Varela, 1998, p. 46). Autopoiesis is then "defined as a network pattern in which the function of each component is to participate in the production and transformation of other components" (Capra, 1996, p. 208). The criteria for an autopoietic network is that it should be "self-bounded, self-generating, and self-perpetuating" (Capra, p. 208).

Capra (1996) maintained that an integral part of the theory of autopoiesis developed by Maturana and Varela is that it undergoes the continual structural changes of self-renewal or development. Developmental changes, he stated, create new structures as a consequence of environmental influences or as a result of the system's internal dynamics. According to this theory, "a living system interacts with its environment through 'structural coupling,' that is, through recurrent interactions, each of which triggers structural changes in the system" (Capra, 1996, p. 219). An example, cited by Capra, is that the cell membrane continually incorporates substances from its environment into the cell's metabolic processes. The environment, he stated, "only triggers the structural changes; it does not specify or direct them" (Capra, p. 219). According to Capra, as living systems respond to environmental influences with structural changes, these changes will in turn alter future behavior. Thus, a structurally coupled system is a learning system (Capra).

Organisms, parts of organisms, or communities of organisms are living systems, according to Capra (1996), and "All living systems are networks of smaller components" (p. 209). Learning communities are living systems. However, Capra cautioned that, for human social systems to be considered as autopoietic, such systems need to remain entirely within the social domain. Social systems, according to Luhnann (as cited in Capra, 1996), use communication as their particular mode of autopoietic reproduction. Hence, the elements of communications produced and reproduced by a network of communications cannot exist outside of such a network. The example of the family as a social system, according to Capra, can be defined as a network of conversations that exhibit inherent circularities. That is, the result of conversations may give rise to further conversations that result in the formation of self-amplified feedback loops. The closure of this network, Capra maintained, "results in a shared system of beliefs, explanations, and values—a context of meaning—that is continually sustained by further conversations" (Capra, p. 212-213). Thus, social autopoietic systems are sustained, transformed, perpetuated, and bounded by discourses.

Cognition, although not considered explicitly by the concept of autopoiesis, can be described using an autopoietic entity. This autopoietic entity, as a self-making system, is a living system. Capra (1996) noted: "Living systems are cognitive systems, and living as a process is a process of cognition" (p. 97). For example, utilizing the creationist perspective to illustrate this, according to Moses in the Genesis account as recorded in the Holy Bible, "God formed man of the dust of the ground" (Genesis 2:7), man existed only in form or only in substance, a dead soul. However, when "God breathed into his nostrils the breath of life . . . man became a living soul" (Genesis 2:7). Man became a cognitive being. Thus, his senses were activated. Cognition was activated by the breath of life. The identification of the mind, or cognition, with the process of life, according to Capra (1996), is a radically new idea in science, but is also one of the deepest and most archaic intuitions of humanity.

Capra (1996) also maintained that not all disturbances from the environment cause structural changes because living organisms respond to only a small fraction of the stimuli impinging on them from the environment. He explained that we can see or hear certain forms only at a particular range of frequencies (many times we do not observe certain things and events in our environment because they do not have any meaning to us) because "what we perceive is conditioned largely by our conceptual framework and our cultural context" (Capra, p. 269). According to the Santiago theory, "cognition is an integral part of the way a living organism interacts with its environment" (Capra, p. 269). The organism does "not react to environmental stimuli through a linear chain of cause and effect but responds with structural changes in its non-linear, organizationally closed, autopoietic network" (p. 269). Therefore, "the organism's cognitive interaction with the environment is intelligent interaction" (Capra, p. 269).

Cognitive Coaching Discourses as an Autopoietic Activity

The phenomenon to be explained can be described as the explanatory qualitative methodology for the theory for *Cognitive Coaching Discourses* as an autopoietic activity. An autopoietic activity is being used as the conceptual system to provide an explanation for the nature of the network of communication in my study as I draw on the parallel nature of the components of both a biological cell—the simplest autopoietic entity—and the study. The systemic approach involved utilized a number of research techniques and certain *tools*—the *tools* of *Cognitive Coaching Discourses*—to generate alternate approaches for the teaching and learning of mathematics in the Jamaican context. The process involved also included various phases while utilizing the *tools* over a particular period of time. During the different phases, a number of learning communities were involved. They utilized the *tools* to generate discourses, brought forth meaning from their environmental experiences, and aided other learning communities to generate a similar learning experience.

The social system considered here as the autopoietic network is the set of "subject-specific teacher collaboratives" utilizing a specific form of the *Cognitive Coaching Discourses* to generate a network of communication. Therefore, for the successful occasioning of this autopoietic network within the school system, a unique climate had to be generated so that the principles and the pattern of relationships which exist in the modes of behavior embedded in this system of communication could take place. Consequently, a constant flow of energy and ideas which result from the examination of experiences through the lenses of one's "states of mind" (Costa & Garmston, 1994, p. 9) was generated by the questions during the five-day seminar series and perpetuated by the cognitive coaching cycles. This was done within the boundary set by *Cognitive Coaching Discourse*—the membrane. All metabolic activities took place within the autopoietic activity, that is the community of teachers using *Cognitive Coaching Discourses* for its communication network.

The non-linear interconnectedness (circularity) of the relationship of the salient elements, tools, or components of this network of communication allowed for the occasioning of certain experiences, namely the act of knowing and doing—cognition. The employment of these *tools* resulted in the feedback loops. This network of communication was also achieved by having participants reflect upon the essential elements of their PDP experiences. Reflection then became the "breath," "life," or the "soul" of the learning processes. It allowed teachers to make meaning and generated the interconnected loops that brought about various kinds of discourses. It involved creating "shared meaning" where very little or none had previously existed.

The various types of *Discourses* which emerged as a result of the utilization of the *tools* and which were maintained by the network of teachers generated the continual creation of new relationships within the network and with students. Thus, Conditions 2 and 3 of Maturana and Varela's (1998) proposed set of conditions for a scientific explanation were satisfied (Figure II) as the formal condition, PDP, and the informal setting, MLE, were generated.

This autopoietic activity involves action and experience, not just on the physical level but also in the way we communicate (Maturana & Varela, 1998). The pathway for communication which would be our starting point establishes the circularity and reciprocity of the connection between action and experience (Maturana & Varela). The dynamic relatedness of the components or *tools* for *Cognitive Coaching Discourses* depicts an on-going set of "metabolic activities" in this unity. These were aimed at learning through personal experience and through the utilization of the *tools* embedded in *Cognitive Coaching* and *Discourses*. According to Maturana and Varela (1998), autopoietic unity should also be self-producing in that the network of interactions will produce the same type that has been embodied while, at the same time, the boundaries of the space in which they are formed are set. This autopoietic activity, therefore, establishes the chief goal of the MLP that would generate a similar cognitive coaching experience to that of the teachers in the PDP for the teaching and learning of mathematics—the *mathematics learning experiences* (MLE) for students in the classroom. This self-generation is inherent in any autopoietic unity in that it reproduces itself in a non-compartmentalized way and also in that the reproduced unities are comprised of the same structures which will promote independence (Maturana & Varela, 1998). This autopoietic activity also satisfies Condition 3 set out by Maturana and Varela and also that which is set out by Vygotsky (1978) where the developmental process "returns to the source and reconstructs all the points in the development of a given structure" (p. 65). Thus, the idea that the PDP will reproduce students' *mathematics learning experiences*—the MLE.

CHAPTER FOUR[3]

THE COACHING APPROACH THROUGH TEACHER COLLABORATION

> *Most strikingly was the effectiveness of the coaching method as demonstrated against the traditional format of didactical instruction, in which we saw the value of the utilization of the creative process in the learning experience. This active mental participation on the part of the learner forcibly registers the desired conclusion that was not stated by the instructor but deduced by the learner; it riveted not only the conclusion but also the reason for the desired conclusion based upon the presented information.* (Newell, Seminar, June 26, 1997)

To make meaning of an action, one has to reflect on it. Likewise, for one to interpret the meaning of one's experiences, one has to reflect on them. This chapter deals with interpreting the meaning of data from the individual interviews (initial and exiting), the reflections on the discourses generated during the seminars, the monthly professional development sessions, the coaching conferences, and from my field notes. This chapter addresses the research question: "*How was the Professional Development Process (PDP) utilizing the vehicle of Cognitive Coaching perceived and accommodated by teachers of mathematics in the Jamaican context?*"

The presentation of findings that emerged from the data is organised around themes which describe the teachers' perception as they utilized the vehicle of *cognitive coaching* during the Professional Development Process. The findings are presented in four major sections: (a) creating the climate for the Professional Development Proces (PDP), (b) The Professional Development Process, (c) The *Coaching Approach*, and (d) The universality of the *Coaching Approach*. The chapter closes with the chapter summary.

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a. A version of this chapter has been prepared as part of a paper presented at the April 1998 American Educational Research Association Annual Meeting, San Diego, California, U.S.A., and has been published. Mclymont, E.F. & da Costa, J. L. (1998). ERIC Document Reproduction Service ED 420 637

b. A version of this chapter has been prepared as part of a paper presented at the 1998 International Multicultural Conference University of Alberta, Canada, and has been published. McLymont, E. F. (1998). International multiculturalism 1998: Preparing together for the 21st century, pp. 236 - 250.

c. A version of this chapter has been prepared as part of a paper presented at the 3rd African Society Conference 2000: Prospects for an African Renaissance. University of Alberta, Edmonton, Canada. February 2000.

Creating the Climate for the Professional Development Process

For any new venture to succeed in the school context and for teachers to be able to embrace the concepts and processes involved, a climate has to be created to do so. Therefore, it is important to have the administration's support and/or involvement for teachers to recognize their need to optimize students' learning and for the Professional Development Process (PDP) to be effective.

Administrative Involvement and Support

Creating a context that empowers teachers requires a supportive organization. Therefore, the administrations' support in allowing the PDP to be a reality was essential. The principals from Dominion High and Jerusalem High were asked to consider the experience of the Mathematics Learning Program (MLP), a professional development process for their mathematics teachers, and a set of *mathematics learning experiences* (MLE) for the students . This was done through my initial written request and at a later date a verbal request.

Initially, teachers of Dominion High were informed about the study and encouraged to participate by their principal, Mr. Dyer. Upon my first visit to meet with him, he invited the Vice Principal, Miss McDonald, and the head of the mathematics department, Mrs. Scott, to meet together with me (Notes, June 11, 1997). He explained that he had invited them so that they, too, could learn the intricacies and be involved in working out the details to allow this program to come about. As I outlined my goals for the five-day seminars, the monthly professional development sessions, and the expected translation of teachers' professional development experiences in their mathematics classroom, Mr. Dyer stated that he envisioned time table changes, among others. At this meeting, tentative dates for both sets of the PDP seminars were suggested by the administration.

Following my meeting with the administration of Dominion High, I met with the principal of Jerusalem High on June 12, 1997. I reiterated what had been outlined in the letter of request for participation and the mini proposal which I sent both principals.

Dates which were suitable for the participants of both schools were decided on (June 12, 1997).

During one conversation, Mr. Dyer expressed to me that my proposed study was in accordance with his dream for mathematics education at his school. He also stated that he was happy I chose his school to share such a program with because he did not have the wherewithal to bring about such a program. The principal of Jerusalem High also expressed interest in my study. When we met, he said he was interested in seeing the final documentation of my study.

Mid-June was a very busy time for teachers and administrators. Teachers were trying to bring closure to the topics they were teaching and to prepare for end of year examinations. The vice principal at Dominion High, who was in charge of the time table, rescheduled the teachers for the invigilation of the examinations so they could participate in the June seminars. The teachers at Jerusalem High, who were also scheduled for the invigilation of examinations, made their own changes by asking fellow teachers to substitute for them so they could attend the seminars. The teachers from both schools attended the first set of three-day June seminars.

The teachers at Jerusalem High taught summer school. Mr. Sloley, the Head of the mathematics department, invited me to visit and observe their classes to see how they were utilizing some of the *tools* of *Cognitive Coaching Discourses* that they were exposed to during the June seminars. However, I was not able to visit their classes at this time. During the summer, Mr. Sloley, and the other male teacher left the school. No new teacher was employed immediately; therefore, the two remaining teachers who were assigned to teach all mathematics classes decided not to add anything to their teaching load and, consequently, chose to opt out of the study. (The contribution of the teachers from Jerusalem High during the June seminars was integral for the generation of the salient elements of the *mathematics learning experiences* (MLE) for the students in the next phase of the program). By September, only Dominion High remained in my study.

The administration of Dominion High freed all four teachers from their teaching duties to attend the second set of two-day seminars for September 3 and 4. Students were not time-tabled for mathematics during this period. Also, in support of my research during the first term of the 1997-1998 school year, the administration created a block of time so all mathematics teachers could be free for two class periods each week to allow for meetings when needed. The timetable was also arranged so that each teacher could be coached by any other teacher.

Mr. Dyer's active involvement in accommodating this study was evident through his interest and participation. Throughout the term, we had occasional informal unscheduled meetings. Another example of the administration's support occurred when Mrs. Scott took over the planning and organization of the professional development meeting for October 22. My original plans for the proposed monthly professional development sessions were considered during this planning. Mrs. Scott asked Mr. Dyer to be a presenter, and he willingly accepted. Being a math teacher, he shared his knowledge with the teachers by focusing on a topic teachers had expressed their discomfort with during their individual interviews.

By mid October, the Mathematics Learning Program (MLP) was making a difference for teachers as well as students, so the administration requested that the new mathematics teachers to the department be a part of the October 22 professional development (PD) session. One objective was for the new teachers to be exposed to aspects of what the other teachers on the MLP were experiencing. Therefore, teachers who had joined the mathematics department in September were invited to join the professional development session. The administration also accommodated this all-day professional development session by rescheduling teachers' classes so they could be freed from their teaching duties.

During the latter part of the term, it became natural for Mr. Dyer to take teachers' classes to allow the coaching process to be complete for teacher dyads. Mrs. Sinclair's statement also verified this when she said, *"Last week we were having a meeting, and we just joined the classes and asked Mr. Dyer to teach it. He did not mind to take the two groups"* (Individual Interview, December 4). Mr. Dyer also mentioned that he would like to experience the coaching process (Group Interview, December 5, 1997).

The support of the principal and his administration created a climate that promoted the integration of my study within the school's environment. It became part of the everyday life of the school throughout the school term as no other activity was given precedence. Support, therefore, became an integral part of the school's culture.

To invite teachers to participate in and to generate a program to enhance pedagogical principles in a school context, the principal's and administration's recognition of the teachers' needs to share and to be involved as a group in this venture, and the active involvement and participation of the principal and the administration were essential to provide support, to create the climate, and to develop the culture for the accommodation of the PDP for teachers and the MLE for students (**Finding # 1**).

Congruence Between the PDP Objectives and Teachers' Needs

All teachers were interviewed individually at their school prior to the PDP. The need for teacher collaboration, teachers' exposure to and engagement in professional development activities, and factors which seem to mitigate against students' performance in mathematics were explored in the interview session to see how closely teachers' felt needs might align to the Mathematics Learning Program (MLP) to be offered.

The Need for Teacher Collaboration

From the interviews, all teachers expressed a need to work with other teachers, especially in the topic areas where they were not comfortable. Mrs. George and Mrs. Sinclair expressed discomfort with certain topics in geometry, vectors, and trigonometry. They felt that collaborating would help them because, according to Mrs. George, teachers "*need a special time together to meet and share ideas*" (George, June 17, 1997).

As I solicited their ideas regarding collaboration, teachers in both schools explained that a limited amount of sharing was taking place between the teachers who have to teach different groups of students at the same grade level. This was done to ensure they "covered" the same topics during a particular term because a common examination was set for each grade level. Hence, even though a limited amount of sharing was taking place during their departmental meetings, Mrs. Sinclair voiced a common conclusion made by all teachers: *"I think if we share more it would help the students and* *help the teachers too*" (Individual Interview, June 18, 1997). She believed that sharing ideas among teachers was integral in aiding students' learning. However, she cited a few hurdles which needed to be overcome: "*As a people we are not ready to have peer teaching; . . . it is not a part of us culturally to have peer teaching.*" Mrs. Sinclair continued: "*The timetable does not lend itself to that sort of thing either, so that we could do more peer teaching*" (I. I., June 18). As Mr. Lennox contemplated the question of "*what could be done to improve the level of sharing,*" his suggestion was, "*perhaps have the administration recognize the need for such.*" For Mr. Lennox, if the administration recognizes the need for teachers to share, then provisions might be made so that the level of sharing among teachers might improve.

All teachers from both schools except Mrs. Jacobson stated that they would not mind having an individual sit in their classes to observe and give feed back. Some teachers stated that since their practicum experience they had not had anyone provide them with feedback. Mrs. Scott, who never had a practicum experience, stated:

> *I would be grateful. (laughs) I keep telling them I have never been assessed! As far as I know . . . they will just walk by or probably be at the door listening, . . . but they never come in and sit in my class and even give me ideas which I would have been grateful for, . . . it has never happened.* (I. I., June 18)

Mrs. Jacobson on the other hand, who has had individuals visit her class, stated:

> *I don't like people sitting in my class. It is a turn off for me and the children. It is disturbing to me. I may have a thought and I may just lose the thought or I may be just nervous to have someone sitting there. Most times I don't even know the purpose of the visit.* (I. I., June 18)

However, Mrs. Jacobson believed that there "*may be one*" of her colleagues whom she trusted enough and might feel comfortable with to have him or her sitting in her class.

Professional Development Activities

Professional development activities were not new for teachers. Teachers stated that at least twice per year one or two of them might be selected to attend seminars or workshops offered by CXC (the Caribbean Examination Council) or the Ministry of Education. All teachers, together as a group, were never privileged to attend these PD sessions. Professional development programs, according to Mr. Lennox, " *that we get through the school are usually those that the Ministry of Education would sponsor but others are personal; . . . you have to pay.* " These opportunities which were offered at least twice per year, according to Mrs. Sinclair, were offered mostly *"during the school term and you are given the time so you can go.* " The teachers at Jerusalem High and Mr. Lennox were engaged in ongoing personal professional development as they were enrolled in courses at various educational institutions. The other three teachers at Dominion High reported their plans to begin their own personal professional development. All teachers stated that they never had a school-generated professional development session.

Factors that Impinge on Optimizing Students' Learning

While teachers believed they had been doing their best to optimize learning on the part of their students, most felt their best was probably not good enough. They felt there were areas they needed to improve on. Also, they outlined several factors they felt negated optimal learning on the part of all students. Among those expressed were ones they felt they had no control over. Teachers' inefficacy in optimizing learning on a larger scale in each of their classes, as expressed by Mrs. Scott, was also voiced by the other teachers as they attributed their inefficacy to: *"gaps in students' learning—lots of prerequisite skills missing, . . . problems with the time frame in which students have to be prepared for the CXC examination, . . . not being able to give extra time to help students, . . . and the lack of equipment—having only 'chalk and box' to work with"* (Interview, June 18). Mr. Lennox expressed his inability to make a difference for each child; this was also voiced by others. Other problems included: *"The diversity among students as learners, students are on different levels; . . . most of them have low self-esteem; and many are withdrawn.* " The students who were withdrawn were also identified by the other teachers as those they have been failing to reach in their classes.

Mr. Lennox and Mrs. Sinclair also felt that the feeder schools, which Mrs. Sinclair termed, *"the catchment area,* " have much to do with the type of students they were getting each year. According to Mrs. Sinclair, *"Our catchment area has changed so* *drastically."* Also, the large number of students they were getting each year from "*single parent situations,"* especially the *"barrel children,"* impacted their ability to optimize learning. These "barrel children," as termed by Mrs. Sinclair, are those whose parents have migrated to other countries and who have been supporting their children by sending "material" possessions to them. So the home situation has also impacted on several students; the teachers also stated that from their perspectives, there seems to be no one to ensure that homework is done. On the other hand, poverty was another item high on the list. As a result, *"the books are not there, . . . on that high priority list,"* and the fact that *"students are traveling"* long distances to school also impacted their poor performance. However, besides poverty and students' traveling long distances to school, all teachers including Mrs. Sinclair lamented that the poor "*attitude for the subject and the fact that some of them are scared of the subject*" were also contributing factors.

Mrs. George attributed students' poor performance in mathematics to the fact that "*They have no interest in school based on their attitudes,*" and they did not practice:

> *What I find most times is that, math is for the classroom and no place else. Once the problem is finished then it is not until the next day that it is looked at. If a concept is taught, I think you should deal with it right away and don't wait for it to get "cold." When it gets cold you forget what was done, and so you have to do it all over again, but while it is fresh you work at it. But these students don't seem to understand that.* (I. I., June 17)

In addition, Mrs. Sinclair noted that the students " *do not want to revise thoroughly. And when you tell them that math is something that you just don't look at but you have to practice, no, they don't practice."* One suggestion offered by Mrs. Sinclair for motivating students who did not have any interest in learning mathematics was the possibility of presenting mathematics in rap-form accompanied by reggae music: (I felt that this was not a bad idea at all; everyone would be dubbing math in the reggae style).

Mr. Lennox, too, had his share of frustration. He stated that *"The overall performance is not that good. Some of the things I provide the students with they are not really responding to . . . they tell you they don't care . . . and that things are better out there."* Mr. Lennox shared his experience that some of his students justified their lack of interest by pointing out that education is not necessary for one to make money:

> *They see persons who do not have any education and they are making it, so they will make it too. They will tell you areas in which they can make money quicker than me and pass me on the road still walking to school. So many of them don't value education. They see education as something for those who want it get it, but it is not a must, it is not a fundamental. Even when you try to show them that it does not matter what job they are going to have in the future a certain level of education is necessary . . . they still don't buy into that.* (I.I., June 18)

Miss. Zanti and Mr. Sloley also mentioned the poor attitude of most foreign students whose parents sent them to Jamaica to receive a high school education at their school. According to Mrs. Zanti, many of these students do not want to study *"because they get whatever finances they want; and if they are not performing well, their parents will take them back to their home countries."* On the other hand, according to Mr. Lennox and the other teachers, students' attitudes were not the only problem; other things for which they cannot be blamed have impacted their effectiveness as teachers and have caused him concern. Mr. Lennox noted four other factors:

> *One, being the teaching method that we have been using in our schools . . . too much chalk and talk. . . .* We *need more demonstrative lessons—let the students do. Two, the un-readiness of our students, particularly coming out from the common entrance system. I feel strongly that they have been drilled. . . . So it is more difficult for the students to assimilate all these things in the different . . . subject areas. . . . The third point is the CXC examination; I think the syllabus is very extensive and the fact that our students are not ready, it is really difficult to get them fully prepared.* Also, *the number of students that are in the classes. . . . I have up to 40! 36, 37 and for a normal class I would say it should be at most 25. So you see it is really a problem, the number of students that you have in each class everyday. . . . You find that you cannot be that effective.* (I.I., June 18, 1997)

The large classes were emphasized by everyone as one of the gravest problems. A suggestion that Mrs. Sinclair offered as a possible solution which could be explored amid the constraints was small classes:

> *I think if we had smaller groups in the classes and were able to do some streaming then you will be able to help students. Like we have math across the year-group so all the very good ones would be in one class . . . and the weak ones you would take and group them . . . but with man-power and the time-table constraints I don't see that possible.* (Interview June 18)

The limitation of resources, the diversity among students as learners, the home situation, poverty, the poor attitudes of students toward the subject and schooling in general, the fact that many students were neither motivated to learn nor valued education, the long distances to school, the direct teaching method, the unreadiness of students' entering high school, the extensiveness of the CXC program of studies, the overcrowded classes, and timetable constraints all contributed to students' poor mathematics performance from the teachers' perspective. However, these factors attested to the need for a different approach in the teaching and learning context. I felt this signaled a "cry for help" which I hoped would be addressed through the alternate approaches to teaching and learning of mathematics that would be generated as a result of this study.

Teachers recognized their inefficacy to optimize learning on a larger scale in each of their classes and attributed their inability to make a difference to numerous factors that impinge on students' learning (**Finding # 2**).

The Professional Development Process (PD)—Phase I

The June PDP Seminars

On Tuesday, June 24, we started the first three days of seminars which were a part of Phase I of the PDP. Teachers were introduced to the utilization of the verbal and non verbal *trust-building tools* of *Cognitive Coaching Discourses*. The utilization of the *tools* that were explored for the development and enhancement of discourse included grouping, questioning, and paraphrasing, among others. These were not explored as separate entities, but were employed in activities that were enacted to generate discourse between and among participants. Mobility, assignment of roles, and grouping essential for optimum learning, were incorporated in the activities. For each activity, participants were grouped in dyads based on unique ways of finding commonality with each other. The procedure involved in each activity was explained and activities were executed. Upon completion of each activity, participants reflected on the activities in their dyads, and then further reflections took place in the large group-setting where dyads came together to form one group. They summarized what they had learnt, what they were acquiring, and what they valued. They also explored how each was applicable to the mathematics classroom. The reflections were video-taped.

Modeling a cognitive coaching experience that involved the mediatory process through the utilization of the *tools*, Mr. Lennox as the coachee and me as the coach demonstrated Bandura's idea that vicarious experiences do help to build one's sense of efficacy. This was video-taped. Teachers related what they observed and what they experienced when the activity was being modeled, and Mr. Lennox related his own experience in the situation. Having observed this model, the teachers reassured themselves about their ability to do similar or better. This activity also became a point of reference throughout the seminar experiences as teachers observed the whole range of behaviors. Even the trivial, which might not have been thought to be significant at the time of observation, became significant. During ensuing discussions, one could see that every aspect of the experiences was indeed adding to the total experience and was essential to coaching.

Teachers were informed when they were invited to participate in the study that the PDP seminars would not focus on the teaching of mathematics, and therefore they would have to translate their experiences from the seminars into the teaching-learning context of their mathematics classrooms. Consequently, for each step of the professional development process, the resounding question teachers asked was: *"How are we going to incorporate these ideas into the classroom?"* However, on the last day of the June seminars, reflecting on their experiences, the teachers deduced what they thought were the salient elements of their learning experience and decided that these should also be embraced as integral to the *mathematics learning experiences* (MLE) for students.

The September PDP Seminars

On September 3, we began the last two days of the PDP seminars. During the June seminars, grouping for activities consisted exclusively of dyads. For the September seminars, we explored another dimension in grouping to include the grouping of three persons. Teachers were also exposed to the remaining *tool* of conferencing, which included planning, observing, and reflecting conferences. Pages 118 to 126 of Costa and

Garmston's book, which provided an example of the planning and reflecting conferences, were made available for teachers. However, they decided not to read this material because they said they did not want their "virgin" experiences to be colored by those of others. However, pages 133 - 141 relating to the "states of mind" which were shared with teachers were read. Conditions for building and maintaining trust were also explored.

After revisiting the salient elements of the PDP that included the *tools* deemed crucial for the *mathematics learning experiences*, the four teachers appeared to be overwhelmed by how these might be "translated" into their mathematics classroom. A mathematics lesson was then planned and tailored to include the use of these tools.

After the planning session, all six persons, the four teachers, my husband, who was videotaping, and I entered the classroom. I had asked Mrs. Scott to tell the students not to be mindful of the rest of us. The students' reaction was quite unlike some teachers' previous experiences in which students would *"clam up"* or freeze when visitors enter the classroom. Students were unmindful of us and treated us as part of the class. After the teaching event, we returned to the seminar room to engage in the reflecting conference.

I hoped the other two teachers would participate in a similar event; however, due to time constraints, this was not possible during the seminars. A date was decided on when all teachers might be available for the total conferencing cycle of the other two teachers, but this did not take place as planned. We ended the session with an overall reflection about what teachers were taking away from the seminars. They were then given a set of questions to which they were asked to respond in written form during their own time over the ensuing week (see **Appendix C** for questions).

The Professional Development Process—Phase II

To accommodate all aspects of the *mathematics learning experiences*, teachers were invited to engage in reciprocated conferencing cycles. The pooling of ideas in the conferencing sessions, along with the whole-group sharing sessions, would serve as an aid to the teachers in generating the new approaches. Therefore, during the first teaching week of school, teachers worked out their conferencing cycles for specific coaching dyads to reciprocate their roles. The time table prepared over the summer was designed to accommodate this. The coaching cycles were such that each teacher would be coached by each of the other three teachers for the duration of the term. Each dyad would reciprocate its role by coaching each other for a period of time, and then the cycle would change to have another teacher coach each member of a dyad. I was asked to be co-coach to serve in a consultative role and to serve as a guide through the process.

This initial plan for the devised coaching cycles did not take place as a result of a rescheduling of classes to accommodate the new teachers to the department in September. Hence, the teachers decided they would engage in their own personal and individual translation of their PDP experiences with their mathematics classes. Pending the new time table, my role as coach emerged for some teachers. By the first week of October, the new time table was posted. Even though it accommodated a block of time as a time for meeting, all teachers were not free at this time, also the time table could not facilitate the pre-arranged coaching dyads. However, the dyad that could engage in the conferencing cycles was formed. For teachers who could not have another teacher coach them because they were all teaching at the same time, I served as coach before they were allowed to re-engage in their individual practices.

The fact that the time table could no longer facilitate the coaching dyads did not prevent teachers from meeting collaboratively. Teachers maximized the use of their lunch time and after school hours for scheduled conferencing sessions and for meeting as a group. Time for planning and meeting did not become a barrier because of the teachers' interest in honing the new techniques and their enthusiasm to effect them in the classroom. The block of time incorporated within the timetable also provided time and opportunity for monthly group sharing sessions, individual conferencing sessions, and departmental meetings.

It was part of my planned activities for the Professional Development Process to have monthly PD sessions. This plan I shared with the teachers when I solicited their participation. However, with the second set of seminars during the first week of September while classes were in progress, with teachers' and students' adjusting to their assigned classes the second week of September, along with the teachers' individual translation of their seminar experiences in their classes, plus a mirad of activities that were taking place during the beginning of the school term, I decided not to have a PD session of the nature I had planned because it seemed pre-mature at this stage. However, since the teachers were given the set of question to which they were asked to respond in written form during their own time after the September seminars, and the fact that they did not respond to the questions in written form, we decided to address the questions in a semi-structured interview format at the first monthly whole-group professional development sharing session on September 22. This PD session served a dual purpose. One, for me to get the teachers' overall impressions of their experiences during both sets of seminars in response to the set of questions given, and the other, for the teachers to share with each other the experiences they were having in the classroom. This PD session was relevant and appropriate.

The first week of October Mrs. Scott shared with me her intents to begin to plan for the October 22 PD session. I was happy for this, because to me it signaled sustainability. A full day's session was planned. The first session took the format of a semi-structured whole-group interview, which was of the format of the September 22 PD session. Questions elicited teachers' impressions of their experiences in the classroom, the coaching process they were experiencing, and evidences of the type of learning that was taking place among the students. The questions served as prompts to the teachers to share their experiences and impressions with one another, with the new teachers, and with me.

The professional development process that included the June and September seminars, the conferencing cycles, the monthly sharing and professional development sessions as part of the MLP were the means to aid teachers in generating the alternative approaches for the *mathematics learning experiences* for students.

The Coaching Approach

The use of *Cognitive Coaching Discourses* as a vehicle for addressing the need for an alternate approach for teaching and learning is an approach and not just a method of teaching. It is an approach because of its level of flexibility and the reflection generated to make meaning of one's action in the everyday teaching and learning environment.

Deciding to Explore an Alternative Approach

The falling of a pebble in a pool of water can create ripples that disturb the entire surface of the water. Likewise, minuscule disturbances can create significant changes to a classroom and school community as a whole. The professional development seminars were designed to help teachers move away from the direct teaching method and to develop and accommodate alternative approaches to maximize student learning in the regular mathematics classroom. The teachers, having decided to generate alternative approaches for mathematics learning in their classrooms, drew from their experiences during the professional development process.

The interactions from the PDP led to a network of interactions among teachers as they collaborated. This networking occurred between and among teachers as they engaged in discourses between dyads and in whole group-sharing sessions. Doing this promoted the "reproduction" or the coming together of ideas to form a new but similar experience for students. The students' experiences were similar to those experienced in the PDP seminars by teachers. These interactions emerged as a result of the mediatory process embedded in the discourses. These experiences were reproduced in situations which involved larger communities, namely the students in the classroom context. Mrs. Scott, revealing the question asked by her colleagues in the other departments, explained what had led to the nature and purpose of this study:

> *I have been asked, "Why are you so accommodating?" But . . . because presently we have what is not working. We know it is not as a result of the lack of content on the teachers' part, especially in upper school. And, I also know it was not the lack of teaching. Maybe it was too much teaching now that we look back (laughs). I know that, but the results were really devastating to the teachers and we needed something to sort of lift the results. . . . I was at my wits end in not knowing what to do.* (I. I., December 9, 1997)

Mrs. Scott felt that direct teaching as the traditional approach to teaching and learning had not been optimizing learning at Dominion High. From her perspective, teachers were not lacking in subject content knowledge. Yet the results of the external examinations (CXC) during the past summer and previous years revealed the need for an approach that would bring about learning by understanding and would overcome factors that were mitigating against optimum student learning. However, she did not know what to do. Mrs. Scott agreed that an alternative approach for the teaching of mathematics was needed to make a difference to teaching and learning.

> *So when you came up with that which was different, this different approach, . . . I said that has to be our weakness, our students regurgitate from memory what we give them, but if the question* [the problem] *is twisted, because they have not embraced it, it is that they can't use their knowledge effectively . . . And so, . . . I was sold from that day, so I was very anxious to get that sort of change very early. So taking on this approach I was more convinced . . . in terms that there was a gap to be bridged between the teachers and the students. Because we were pouring out and nothing seems to be staying in, and so I was sort of convinced at the workshop and I was more than willing to try.* (I. I, Dec. 9)

Comparing what they as teachers had experienced in the PDP seminars with what usually happened to their students, Mrs. Scott explained that most students did not show an understanding of concepts based on their responses to mathematical problems which were not framed in a straightforward manner. However, her experiences during the seminars revealed the gap to be bridged between teachers and learners, and led her to be partially convinced about the nature of the approach. As a result she was willing to try.

Students' inability to perform was also attributed by Mr. Lennox to *"the teaching methods—too much chalk and talk."* He also suggested that *"more demonstrative lessons to let the students do"* were needed because the *"instructional formats"* generally used include situations where *"information is given orally as well as in written form on the board, or they are given sheets of paper . . . with instructions to follow* (Interview, June 18).

After being exposed to the mediatory process to effect interactive *Cognitive Coaching Discourses* as a learner himself and being given the opportunity to analyze the implications for the teaching and learning of mathematics, Mr. Lennox proposed that *"using this kind of approach in the classroom situation might really help to get the students turned on for the learning process"* (Seminar, June 25). Mrs. Sinclair also stated: *"The ideas that I had learnt from the seminars . . . should influence my students' overall performance and holistic development if I implement in the classroom some of what I learnt yesterday."* (Seminar, June 25). The teachers, having had the opportunity to explore the implication of each aspect of the mediatory process of interactive *Cognitive Coaching Discourse* and its application within the classroom context, hoped to effect a similar type of learning context for their students in their mathematics classrooms.

Mr. Lennox stated that he viewed this mediatory process as *"a means of conveyance to get across information in a meaningful and purposeful way, and after the process has been carried out there will be evidence that the messages or concepts that are being conveyed have taken place"* (Seminar, September 4). Reflecting on their first exposure to the overall experience of the mediatory process of interactive *Cognitive Coaching Discourses* at the end of day one on June 24, teachers stated that this process was different from training in that it was *"not imposing,"* while *"training is like being in the army."* They stated that, in this process, *" each person's contribution is very important," "each person is a part of the group,"* and it *"encourages each person to share and not to give mandates."* It is *"not mandating,"* they reported, but encourages one to *"make suggestions."* It also *"engenders a friendly relationship"* in which the *"mediator has the ability to draw from the environment and shape the . . . atmosphere to solve a problem."*

Having been exposed to the process involved in *Cognitive Coaching Discourses* during the seminars and after beginning to translate their experiences in the classroom, the teachers decided that it was worthwhile to explore its use in the classroom. Mrs. Scott acknowledged: *"We will all like to continue and take on the coaching thing"* in our classes (PD Group Interview, Sept 22). They also stated that they looked forward not only to translating their experiences but also to participating in the total Math Learning Program. Mrs. Scott also reinforced this by stating that *"We have all decided that we will participate"* in the MLE (PD G. I, Sept. 22).

Perceiving this approach as different from the traditional approach, teachers were convinced of their need for an alternate approach to bridge the gap between their mode of teaching and the way their students as learners learn (**Finding # 3**).

"The Cognitive Coaching Approach"

Group discussions during the professional development sessions generated interactions which gave "life" to this study. Throughout the seminars ongoing opportunities for reflections were provided for teachers to derive their own meanings and applications of the process involved in the interactive *Cognitive Coaching Discourses*. Mr. Lennox, reflecting on the meaning he derived from his experience with the mediatory process involved in *Cognitive Coaching Discourses* while a hypothetical personal goal was mediated for, made additions to Costa and Garmston's (1994) definition for Cognitive Coaching. He stated,

> *Coaching is a means of conveyance. Cognitive Coaching is helping an individual to think through a problem situation. It is getting the individual to analyze, synthesize, and simplify. It helps the individual to evaluate and assess a situation through the use of good questioning techniques. The coaching exercise is basically one that helps the person to make a decision about his or her idea without imposing one's idea on the person. It helps the person in that if he needs to make a decision on a particular issue, it is done without interference from the coach. It is a facilitating role, not a dictating role. As a coach you are a facilitator, not a dictator.* (Seminar, June 24, 1997)

The other six teachers observing this model of interactive discourse through their vicarious experiences reinforced and made additions to Mr. Lennox's definition of the mediatory process of *Cognitive Coaching Discourses*. For Mrs. George, *"it's the sharing of ideas. It is helping one to make one's own decisions,"* while Mrs. Scott stated that it *"is the process involved in helping an individual in an individualized situation to explore his or her inner thoughts and ability to achieve particular goals until it enhances performance by the process of delivery and application."* For Mrs. Sinclair,

> *Cognitive Coaching is listening. It is questioning. It is paraphrasing. It is not changing a person's goal. Cognitive Coaching is a creative process; it helps you to solve your own problems without interference from the person who is helping you. Cognitive coaching allows the learner to analyze; it is a facilitator of decision making.* (Seminar, June 24)

While I mediated the strategies that provided the alternate means for achieving Mr. Lennox's hypothetical goal during the discourse, the teachers were observing. They, too, were formulating their own questions as they were being carried through the process.

They were experiencing elaborations and additional dimensions to their thinking. They stated that some of the questions they thought of were not similar to mine and they did not think of some of the questions I asked. However, those which they shared were viable alternatives. These alternative questions and suggestions were influenced by their personal history or previous knowledge as there were no prescribed questions. Consequently, persons observing Mr. Lennox and me were also conveyed along the path being mapped out. Mr. Newell summarized what was happening to them as observers. He stated, *"We participated in his decision making process, with his anticipation, his questioning, mentally looking for the alternatives, and then accepting or rejecting them as being feasible or ridiculous"* (June 24).

Teachers, after observing the model of the mediatory process involved in the *Cognitive Coaching Discourses* with Mr. Lennox and me, were introduced to the same concept: the role of a mediator using direct teaching. After the direct teaching exercise, I questioned them about what they had learnt. They did not respond spontaneously as they had when the process was modeled; instead, they all looked back to the notes they had taken during the teaching exercise. One teacher, Mr. Lennox, had left the room after the direct teaching exercise and had returned after everyone else had given their responses to the particular questions. Without directly or indirectly calling attention to the way he would respond, we observed with interest and laughter how he responded to the particular questions. True to form, he, too, went back to his notes to retrieve what was given by the "teacher." Reflecting on this experience, Mrs. Scott deduced that:

> *I think this is basically what happens to our students (laughs). I do believe this. Here it is, in almost note form, point by point, the information was given back (Laughter—everyone). It was as if he did not have the paper, he would not have been able to respond . . .* (laughter). (Seminar, June 24)

Teachers saw that when one was not personally involved in the learning experience directly or vicariously, regurgitation took place. They noted that everyone had the same notes, and everyone responded by giving back the information in the same order. The only difference was the choice of words. The rigidity displayed was obvious to all teachers involved in this PDP session.

We all felt that learning by understanding had not taken place in this direct teaching exercise. Because teachers were locked into their notes, they did not make the connection or even recognize that it was the same concept that was explored in the previous modeled situation with Mr. Lennox when they were all able explain the process involved in *Cognitive Coaching Discourses*. The only difference was the terminology that was used—mediating. The only thing the teachers focused on was their notes. Examining this direct teaching experience was also an opportunity to reflect upon their own classroom practice.

During the PDP seminars, teachers as learners were stimulated to redirect, clarify, and extend their thinking utilizing the *tools* of the interactive *Cognitive Coaching Discourses* with which they were familiar. Hence, compartmentalized, encapsulated, and disconnected bits of information could now be pooled. As they extended their knowledge, they generated alternatives and their thoughts were stimulated as they utilized that which they already possessed to generate new ideas and ways of doing. Consequently, on day three of the June seminars, Mr. Newell, while reflecting on their overall experiences, remarked:

> *I think we are being made consciously aware of elements that we were already utilizing, but not in the co-ordinated form, lending to the effectiveness of the whole as it is. We are co-ordinating, taking and putting them into a whole as we pool our ideas.* (Seminar, June 26).

Using the mediatory process of *Cognitive Coaching Discourses* during the seminars demanded maximum participation on their part as they engaged in the interactive processes. Looking back, Mrs. Scott related the difference that their seminar experiences provided:

> *Putting everything else together you learnt, you participated, you got a chance to revisit what you learnt, and you got a chance to put that which you have learnt into action. And after that, you were able to evaluate it immediately whether or not you thought it would work or whether or not it could work. Rarely in seminars do you get that chance. Most times you are lectured to, and you are expected to make this work. But in this seminar the difference was, you were able to participate; you were able to immediately put the thing into action and therefore you could get feedback while in the conferencing activity.* (PD G. I., Sept. 22)

From Mrs. Scott's reflection about what transpired in the seminars, it was my perception that the seminars were the beginning of the teachers' empowerment because this approach afforded them the chance to participate in and to put into action what they were learning. At the same time, the situation allowed them to revisit what they were learning through reflection. They recognized that the *tools* employed in *Cognitive Coaching Discourses* allowed them to draw on previous knowledge for the activities they were engaged in. The mediation involved in the *Cognitive Coaching Discourses* allowed disconnected bits of knowledge to come together to form a connected whole. Hence, a network of interactions resulted from the reflections which took place in the small-group settings as well as in large group settings as participants collaborated by voicing their ideas, interpretations, and experiences.

As the four teachers embarked on translating their PDP seminar experiences into their classrooms, the community of teachers in the mathematics department was affected in more than one way. The three new teachers, Mr. Gilepsie, Mr. Mutherland, and Mr. Intresteed, who joined the staff in the mathematics department in September and who were invited to participate in the October professional development session, were made aware of what was happening in other teachers' classes at this session.

Listening to the interactions during this session, Mr. Gilepsie asked: *"Is coaching an approach or a method of teaching?"* Probing for his meaning of the terminologies used, he responded by distinguishing a method from an approach by stating that a *"method"* is used only in the teaching of particular topics; whereas an *"approach"* is used generally for all topics in any subject area. Consequently, all teachers responding to his query affirmed in a chorus that Cognitive Coaching is an *"approach"* based on their experiences with the utilization of the *tools* of *Cognitive Coaching* in the various teaching and learning situations (PD, October 22, 1997). Hence, from the discussions and sharing of experiences the obvious became more real—that the utilization of the *tools* of *Cognitive Coaching* generates an approach—a different approach for teaching and learning. Within this document from this point on, the teachers' name to identify their experience with the *tools* of Cognitive Coaching is referred to as the *"Coaching Approach."*

The utilization of the *tools* of *cognitive coaching* generated interactive *Cognitive Coaching Discourses* which further generated an alternate approach to direct teaching—the *Cognitive Coaching Approach* for teaching and learning (**Finding # 4**).

Tools of Cognitive Coaching → *Cognitive Coaching Discourses* → *Cognitive Coaching Approach*

Flexibility in the Coaching Approach

Thinking begins in a situation that presents perplexities or dilemmas. From the dynamic network that was taking place among students and teachers as a result of this approach, one had to be flexible. According to Mr. Lennox, *"with this coaching approach what . . . I have found out is that, in preparing, that is in the conferencing, even if something comes up that I did not prepare for, because of the level of flexibility, I just found myself able to do it* (PD, Oct. 22). Mr. Lennox, in his December interview, expanded on the nature of the level of flexibility that the *Coaching Approach* had exposed him to:

> *The whole experience that I have had with my colleagues coaching me as it were before I have gone to a class to teach, what I have discovered is that . . . based on that process it has helped me to be more alert to the different things that might happen in the classroom. So I was much more empowered and equipped. To a great extent I have discovered that a level of flexibility can be achieved for me in the coaching experience.* (I. I., Dec 4)

As a result of the mediation of alternative strategies for the teaching of particular concepts during the planning conference, Mr. Lennox's consciousness had been raised about possibilities which could take place in the classroom. He felt this promoted flexibility as he was empowered and equipped to deal with any classroom situation which might arise. He explained further that the planning conference experience empowered him for the execution of the particular lesson:

> *The . . . experience before I go into the classroom has empowered me; for example, some things that I have planned to do I might find that the response is not there. But based on what I have gone through already, it is like somehow it just clicked "here is another alternative." And in executing the lesson you have at the back of your mind, "What if something like that happens?"* (I. I., Dec. 4)

The coaching session Mr. Lennox experienced prior to the classroom teaching experience created an awareness for alternatives which were always coming to his mind for any particular situation he might face in the classroom. Therefore, for Mr. Lennox, the probes generated a level of flexibility. He went on to state:

> *When I am being coached by someone and they are probing for the specifics, as a result, a level of flexibility occurs, . . . it is like as it were I was not thinking before, but because the question was asked it just comes out. It forces you to think of an alternative. It challenges my mind to think of an alternative. What is it that I would do in the situation?* (I. I., Dec. 4)

For Mr. Lennox, flexibility, in terms of generating multiple solutions or ways of dealing with any issue that may arise in the classroom, is propelled by probes embedded in the *Cognitive Coaching Discourses* generated during the planning conferences. Mr. Lennox hastened to add, *"I must also mention that . . . normally if I were not asked or if I were not exposed to this kind of experience I would not have taken thought."* He confirmed that the mediatory process involved in the discourses raised his consciousness to generate a repertoire of alternatives that helped him deal with any situation which may arise. Also, the mediation of these alternatives raises his consciousness to make him aware and flexible. As a result of the process that is involved in this experience, he stated:

> *I am not taken by surprise. It might not be something that has been discussed during the coaching experience in the planning session but the fact that I have been exposed to that kind of strategy, I am not taken by surprise.* (I. I., Dec. 4)

Consequently, if the particular alternative was not thought of during the planning conference, he was now flexible enough to generate a response acceptable to the particular situation. He was able to "think on his feet" in any situation. He is now never caught in a dilemma as to how to deal with any issue. He is *"not taken by surprise."*

Mrs. Sinclair also confirmed a similar experience to that of Mr. Lennox's but with a different dimension. With the usual laughter that attended all our discourses, she reported:

> *I think this new approach has taught me to be far more flexible. . . . You don't go to class right now with a one set mind. You go inside there expecting the unexpected. As you now know that many methods can come up for the solution of a particular problem. So for this approach one has to be very flexible. (Dec 4)*

Because students were generating many alternative solutions for mathematical problems in their small group situations, teachers went to class expecting anything. This was not only typical of Mrs. Sinclair's classroom but also of any class in which the *mathematics learning experiences* (MLE) were introduced. Mrs. Sinclair went on to explain the measure of flexibility with which one has to enter the classroom to be open to alternatives, thus enhancing one's own pedagogy:

> *You don't go to class now with a fixed way saying, "This is the way I want this to be done." No! you can't go with that anymore. So you are flexible. Of course you have to prepare more. . . . The students are coming up with various alternatives. But because you are preparing more, your mind is open as well and some things that were foggy in your mind become clear. . . . And you know the approach is different, . . . you know that, just different.* (Dec. 4)

According Mrs. Sinclair, to be flexible in this type of classroom, the teachers have to ensure that they prepare thoroughly because of this different approach. Mrs. Scott, during the October 22 PD session, explained the rationale for her flexibility. Her thorough preparation revealed her ability to cope with the alternative methods of solution which students were generating for mathematical problems. She stated emphatically: *"You have to prepare the topic thoroughly, seeing that you are not the one who will now teach the students mechanically one step, two steps, three steps."* She further explained:

> *The fact that you are not prepared and if a child should take another approach, because you are not acquainted with the topic enough, you as a person are going to stay in this old rigid state; since it is not you who will be telling, . . . so you have to be more flexible.* (PDP Oct. 22)

The teacher's role in the classroom was changing from dispensing information and outlining how problems are solved using the teacher's method of solution. However, if teachers were not familiar with several solution paths to a particular problem, they would be inflexible towards the solutions generated by the students. Mrs. Scott further explained:

> *You have to be flexible because even if you have eight groups and you tell them to come up with a solution they might come up with 8 different ways, and you are in a serious problem if you know only one way. For example—simultaneous equation—if you only know elimination and the child comes up with substitution or a combination, or some students do it using trial and error, if you don't know,*

> *you are going to get very rigid and you will now shut down the child's whole thinking process because you don't know the process the child may use. So I think it forces you to know your material in addition to being flexible.* (Oct. 22)

According to Mrs. Scott, the students' creativity depends on the teacher's flexibility. If the teacher is not flexible, then whenever a group generates a solution path different from the one that the teacher is comfortable with, the teacher, not being aware, might not accept the solution process offered by the students. Thus, the child's thinking process is stalled. On the other hand, if the teacher makes thorough preparation, whatever path a student may use to come up with a solution, the teacher can see it as valid or invalid and will be able to offer the necessary suggestions concerning its correctness.

Mrs. Scott, in her December 9 interview, again stated that she believed that this approach " *has affected all my states of mind. The first one to go was rigidity.* " Expanding on what was stated in the October PD session, Mrs. Scott stated that using the old approach

> *We tend to be very rigid and as a result you thought you were flexible because you had one, two, three methods and you would probably even want to boast . . . if you compare yourself with your colleagues, but in a sense you were still very rigid because the fact that you had three and you would teach the students these three ways, this approach in itself was being very inflexible.*(I. I., Dec. 9)

According to Mrs. Scott, the previous approach was inflexible because it was the teacher dispensing information to the students. On the other hand, the *Coaching Approach* impelled one to be more flexible. She added,

> *But the coaching has allowed you to be more flexible. Flexible in the sense that you, but not just in the coaching, but the whole approach, because in the coaching someone might come up with an alternative and if you think about it, it will force you to know it, but when you get into the classroom, students might not use your approach or the one that was recommended in the coaching but at least the coaching helped you to be prepared for . . . the alternatives.* (I. I., Dec. 9)

The coaching conferences also promoted flexibility. As stated by Mr. Lennox and Mrs. Sinclair, being forced to think of alternatives during the planning conferences or to examine alternatives suggested by the coaching partner aids in allowing one to be open to other alternatives students might come up with in the classroom. Mr. Lennox affirmed that flexibility among the students in the classroom was obvious. He stated emphatically:

> *Definitely, among the students it is quite obvious with the implementation of this program wherein the students within their groups are actually been forced to be flexible, in terms of the roles that they play . . . because it is not just that the teacher is teaching them something, but they amongst themselves are forced to be flexible. Also the state of mind in terms of interdependence, there is more sharing; you will find that they are now asking questions, "How did you arrive at that answer? What has caused you to think that way?" just to name a few of the questions that they have been asking. So all in all, it has been impacting on the students when thinking of alternatives.* (I. I., Dec 4)

Students were also flexible in terms of the level of interdependence they exhibited within the small groups. Their flexibility was pronounced in the way they were questioning each other and generating alternative strategies for solutions to the mathematical problems. Mrs. Sinclair also validated Mr. Lennox's experience as she, too, made a similar deduction and an elaboration:

> *The students, I think, are far more flexible. They are not afraid to try something new . . . and right now they don't have to depend on the roles; I don't even know who is playing what. They find it very comfortable and they are working together in their groups.* (I. I., Dec 4)

The teachers were questioned about another dimension of the flexibility of this approach and whether it could be used without being altered across grade levels. They were asked: *"What is the transition program you have for those students coming out of the primary* [elementary] *school situation?"* (PD, Oct. 22). Mrs. Scott explained that there were classes from Grades 7, 8, 9 and 10 on the Math Learning Program, so *"I don't see any sort of problem with transition."* She continued to explain that the philosophy regarding grouping is for students to work with friends. They might not ask the teacher certain questions in a whole class situation but, within a group, they would naturally ask their friends because of the level of interdependence that naturally exists. She explained: *"So this sort of interdependence . . . is nothing new to them. It is just that this approach encourages it, . . . encouraging their normal behavior. So I really don't see a transition problem."* In addition, Mrs. Sinclair elaborated the philosophy regarding grouping that was embraced: *"What we are doing now is to use that peer group pressure to enhance learning"* (PD, Oct. 22). Therefore, the *Coaching Approach* capitalizes on the natural human resources at hand within the students' mathematics learning groups to enhance and maximize learning and to generate flexibility among teachers and students. Hence, the teachers also felt that the *Coaching Approach* was flexible because it also transcended grade-level boundaries.

Mrs. Scott and the other teachers could not help comparing flexibility in terms of the behaviors of their students exposed to the *mathematics learning experiences* and the rigidity of those who were not. They observed that the Grade 11 students who were not exposed were dependent on the teacher: *"It is the teacher who must tell them"* (Mrs. Scott, PD, Oct. 22). Mrs. Sinclair also stated that because her Grade 11 students had not been exposed to the *mathematics learning experiences*, they were not flexible. As a result, *"they are still dependent on me for the correct answer . . . they don't have like the Fourth Form* [Grade 10], *that inquiring mind . . . to find out and check their answer"* (I. I., Dec. 4).

The *Coaching Approach* encourages flexibility among teachers as well as among students as they generate alternative strategies for the solution of problems in the teaching and learning situation. The flexibility of the approach also enhances a higher level of interdependence and openness as alternatives were mediated within the learning groups. The *Coaching Approach* transcends grade level boundaries in that interdependence within peer groups was also enhanced.

Hence, the *Coaching Approach* encourages individuals involved in the teaching and learning communities to be flexible (**Finding # 5**).

The Coaching Approach is a Reflective Approach

The demand for a solution to a problem serves as the steering factor in the process of reflection. During the PDP seminars, the uncertainty of how participants' experiences would be translated into the classroom triggered continuous interactions and ongoing reflections. Consequently, as participants reflected, they identified what they were *"valuing," "anticipating," "acquiring," "internalizing"* and *"reacting to."* They were also *"wondering if"* what they were being exposed to would work and how they would translate their own experiences in the classroom.

Thus, the thought processes, the actions, and the reflections all became an integral part of the "life" of the discourses which were generated. The teachers reflected on the importance of the seminar activities they had engaged in, and they stated what they valued. Understandably, each person did not necessarily value the same elements of the *Cognitive Coaching Approach,* but the salient aspects were of value to all. For example, Mrs. Sinclair, Mr. Lennox, and Mr. Sloley stated that they valued *"rapport,"* while Mrs. Sinclair and Mr. Lennox stated that they valued the *"openness and sharing, the coaching techniques,"* and *"the way the activities forced one to verbalize."* Mr. Newell stated: *"What I value highly is the practical demonstration of the skills that I am desirous of inculcating. The step-by-step application of the concepts at work in the overall techniques effects a building process*" (Seminar, June 26).

Mr. Newell's query that projected his thoughts on the classroom situation was, "*I wonder if these innovative techniques can be brought to bear on a larger scale so as to effectually revolutionize our teaching method?*" After only two days of the seminars, Mr. Newell wondered how this new approach to teaching and learning they were experiencing would influence the larger setting of learners in the regular classrooms. Their thoughts were projected to the anticipated teaching and learning of mathematics. Mrs. Sinclair, too, questioned the possible use of the techniques: *"I wonder if these innovative techniques would enable me to complete the CXC math syllabus?"* Mr. Sloley reflected on group dynamics, stating: *"I wonder if more persons were in attendance if we would have participated as we did?"* He also wondered how the type and level of participation with a group of 40 students would compare with the participation of the group of teachers. Mr. Lennox, contemplating one technique involved in effective discourse, stated: *"I wonder if there should be some specific time that should be allowed for 'silence and wait time' before responding to persons?"* Mrs. Sinclair also wondered if her students would see her "*only as a friend and not as a disciplinarian after all this coaching*" (Seminar, June 26).

Teachers also acknowledged what they were internalizing from the experiences. Mr. Sloley stated, *"I am internalizing the new approach,"* while Mrs. Sinclair declared: *"I am internalizing the coaching techniques, the questioning techniques, and the relaxing atmosphere, and how to develop trust."* Mr. Lennox, on the other hand, observed *"the* *activities really have made an impact on me and I am really encouraged and motivated because I am getting something and I am feeling good."* Mr. Newell, projecting his thoughts to the classroom situation, stated: *"I am internalizing and seeking to utilize the concepts being demonstrated not only in the classroom but in my personal life"* (Seminar, June 26).

Reflecting on how they were reacting, Mr. Lennox and Mr. Newell stated that they were reacting *"positively."* (Seminar, June 26) In Mr. Newell's case, he was reacting positively because he was *" interested,"* his mind was keen, and he was *"assimilating the information."* He also noted that he anticipated *"learning more and being able to successfully utilize the knowledge and eventually seeing it successfully borne out on a larger scale."* Mr. Lennox, in the same vein, anticipated *"that the implementation of the coaching approach in the classroom will make a positive change in the behavior and performance of both students and teachers,"* while Mrs. Sinclair anticipated a better understanding of the communication with her students as well as with her colleagues. She also anticipated a greater participation from her students, especially those who were introverted. Mr. Sloley noted that he was anticipating the response that he would be getting from his students as a result of utilizing what he remembered from the seminars (Seminar, June 26).

Reflecting on key aspects they were acquiring while collaborating, Mr. Sloley stated that he was learning he should be tolerant and patient with students and *"that body language unconsciously or consciously will have an effect on students."* Mr. Lennox noted, *"I am learning strategies and approaches that will equip me to be more effective as a teacher."* Mrs. Sinclair, on the other hand, stated, *"I am learning to listen to other persons' ideas, and to be flexible. I am also learning that each child is a creative being and that sharing is a powerful medium for creativity."* Mr. Newell observed that he was acquiring *"the tools for facilitating communication, particularly paraphrasing and its subsequent dimensions, and also probing."* Mrs. Scott, adding another dimension, stated: *"I want to remember the working together; the way you kept on grouping us; every minute changing the groups; I think I really want to remember that"* (Seminar, June 26).

Reflecting on the total experiences of the June and September seminars, teachers providing one-word summaries to describe their enacted experiences, stated that the experiences were "*enjoyable, different, unique, uplifting, eye-openers, meaningful, interesting, relaxing, classic,*" and "*transforming.*" Mrs. Scott elaborated: "*Transforming in terms of seeing yourself as you respond . . . just to layback and watch yourself . . . in this setting letting down your guards*" (Seminar Sept. 4).

Throughout the PDP, teachers were constantly metacogitating. They were reflecting on what they were learning and how what they were learning could be translated into the classroom. The reflecting conferences teachers were engaged in throughout the term served a dual process: they aided the recall of classroom events and they also provided insights while reflecting on the events. The *Coaching Approach,* according to Mrs. Jacobson, demanded constant "*reflection.*" As she compared the *Coaching Approach* with other programs, she stated: "*This is different because there is no reflection*" in other programs that she was exposed to. "*We did not reflect on what we did,*" she observed. Mrs. Jacobson also noted the reason for reflection: "*because you can improve on a class when you stop to think about what you have done or have not done*" (I. I., Dec. 4). Mr. Lennox also endorsed this, stating that the generation of constant reflection triggered by the conferencing activity provided a level of continuity and clarity in thought process, as well as helped to identify weak areas while preparing him for the unforeseen:

> *This approach is a more reflective thing; usually you would just do some little things, but now by the person who is coaching you, asking you some more questions in the planning conference, causing you to reflect on what has happened. Also going through the reflecting conference, I am always reflecting on what has happened. Further, it provides you with a level of continuity. You know where your weak points are, . . . and what I have discovered with this approach is that you can always cater for the unexpected* (I. I, Dec. 4).

Reflection is the act of making meaning. Therefore the uncertainty of how participants' experiences during the PDP seminars would be devolved to their students into the classroom triggered reflection on what teachers were valuing, internalizing, acquiring, and anticipating. The planning and reflecting conferences also served as a tool for the generation of reflection.

The *Coaching Approach* induces reflection to provide continuity and to make meaning of one's experiences (**Finding # 6**).

The Universality of the Coaching Approach

The *Coaching Approach* is a universal approach that seems to broaden the pedagogical horizons of the teaching and learning context by facilitating learning by understanding, acting non-judgmentally, promoting coaching as a means of discovery learning, eliminating teacher isolation, and promoting freedom of self-expression.

The Coaching Approach Facilitates Learning by Understanding

Experiencing is understanding; and understanding through experience is learning by understanding. *"With this Coaching Approach, what I like about it is that it has built my level of consciousness from mere knowledge of teaching and learning to experience procedures involved in the classroom;"* Mr. Lennox declared (PD, October 22). Again in his Dec. 4 interview, Mr. Lennox stated reassuringly that the approach has impacted on him

> *very positively, in the sense that I am much more aware. It is like you have been doing some things for quite a while but did not have that kind of process like what has been involved in the coaching. You know you were not aware; I was not aware of some of the things that I have discovered.*

Learning through experiencing led to awareness and discovery for oneself of certain processes. Mr. Newell's claim during the June seminars supported this:

> *Participation in the workshop yesterday was the most potent educational experience that I have had; the techniques of presentation forcibly riveted in my mind the desired concepts before the presentation actually stalled the conclusions that should have been derived.* (Seminar, June 26)

For example, from the *Cognitive Coaching Discourse* modeled by Mr. Lennox and me, teachers were able to make their own deductions about the objectives of the process, what was being done to the coachee, the role of the coach, and what was really involved in the process (Seminar, June 24). Also, Mr. Lennox stated that from his deduction of the overall processes that he was exposed to in the seminars, he was learning strategies and approaches that would be more effective for teachers in the classroom context (Sem. June, 26).

Throughout the seminars, the teachers compared the traditional mode of instruction with the *Coaching Approach*. Mr. Newell summarized this comparison as he reflected on his experiences during the seminars:

> *Most strikingly was the effectiveness of the coaching method as demonstrated against the traditional format of didactical instruction wherein we saw the value of the utilization of the creative process in the learning experience; as this active mental participation on the part of the learner forcibly registers the desired conclusion. It is not stated by the instructor but deduced by the learner, thus riveting not only the conclusion but the reason for the desired conclusion based upon the presented information.* (Seminar, June 26, 1997)

Mr. Newell felt that the mode of presentation of concepts was in contrast with the direct teaching method. In the *Coaching Approach*, the learner had to be personally involved because of the creative process utilized in the learning experiences. The experiences provided the occasion whereby learners deduced the desired concepts and principles. Teachers were moved beyond a mere knowledge of teaching and learning to educe the latent principles embedded in the approach. This mode of learning was perceived as learning by understanding. The *Cognitive Coaching Approach*, Mr. Newell noted: *"is intelligently facilitating the development of realizable goals and practical strategies, inculcating critical thinking, and sparking the creative process in the individual being coached* (June 26).

The coaching/conferencing as an integral part of the *Coaching Approach* is not only thinking about thinking—metacogitating and reflecting—but about redirecting one's thoughts and voicing perceptions. The recursiveness of these interactions and the dynamics of the environment—triggered thought processes and discourses that opened a highway of possibilities for teachers. According to Mrs. Scott,

> *The coaching helps to redirect your thinking. So even if you are just on this one track road, it would have opened up an entire highway; these are the possibilities, and definitely when you go to the class, these are the possibilities and more.* (I. I., Dec. 9)

Instead of acquiring factual knowledge or just practicing a set of skills, as was done in the "old school," the dynamic process of the *Coaching Approach* led teachers to a new level of understanding as they developed mastery of the use of the questioning technique involved in the approach. The employment of the questioning technique by teachers aided students in overcoming the hurdles they faced. Mrs. Scott noted:

> *Another thing is that you are determined to develop mastery of it because the kids are coming in from different angles. Different things are popping up and you may find a weakness in algebra, you may find a weakness in the thought process, you may find a weakness in different concepts; . . . so it forces you to develop mastery so that wherever the little hitches are, you are able to help students from there by questioning them to redirect their thoughts back to where they are going and helping them.* (I. I., Dec. 9)

To verify that learning by understanding was taking place in the classroom as students solved mathematical problems by employing the *Coaching Approach*, Mr. Lennox averred:

> *Also, there is a test for knowing how they come about the solutions for a problem. The kind of questions I have heard the students asking is really showing that the kind of learning that is taking place is not just the kind where they regurgitate, but of getting a concept, the discovery type. So that is another plus to the coaching.* (PD, Oct 22)

Mr. Lennox, also in his Dec. 4 interview, reinforced the difference in the way that the students were approaching their written work:

> *I have observed the difference in the written work in terms of their presentation. It is as if in some exercises they were asked what is it that they are doing in a particular line or so forth; you find that students are now using that type of approach in general in solving problems. So they are not just looking for writing down an answer but they are willing to show the steps.*

Mr. Lennox observed that the kind of discourses in which students were engaged within their small group activities influenced the presentation of their written solutions. As a result, his assessment practices no longer involved just looking for the right answer where the processes used were not revealed, but *"there it is now, when the students put out exactly what they have done, you know clearly that the understanding is very much there."* This *Coaching Approach*, Mr. Lennox affirmed, has impacted the students' performance in mathematics: "*So I see more learning of mathematics and the whole improvement of results are coming in the picture in this kind of impact that it has on the students* (I. I., Dec 4). Mrs. Sinclair, too, added that for her class that was utilizing the *Coaching Approach:*

> *For mid-term, my lowest mark was 32 out of 60. I am very pleased with the results . . . I don't know what the end of term results will be like . . . some of them have really reached the level of craftsmanship; they are really understanding and learning on the whole. This morning I did not expect anybody to come up with the factorization of the quadratic expression with "a" greater than one. I did not expect anybody to do it and they did.* (I. I., Dec. 4)

Mrs. Scott also reported that the assessment techniques she was employing were influenced by the students' approach to the solution. Their approach revealed that they were making connections and not just regurgitating. Therefore, the *Coaching Approach* changed her understanding of how one learns:

> *You no longer evaluate the child on whether or not he is able to regurgitate what you just said and how you did it, but it is more of how the child approached it and solved it and how they think. So it has changed that mind set of how we learn, and they are making connections with other things that they had embraced and no longer would you as a teacher do a little direct teaching and expect them to embrace it immediately, . . . which I think was my error before.* (I. I., Dec. 9)

Experiencing is learning by understanding that moves one from mere knowledge of teaching and learning to participating and making deductions. The act of experiencing triggers the creative process by critical thinking that leads to mastery and discovery learning. This learning by understanding is reflected in students' presentation of solutions of mathematical problems, impacts changes in teachers' assessment practices, students' performance, and the enhancement of teachers' and students' craftsmanship.

Consequently, the *Coaching Approach* facilitates learning by understanding as the act of experiencing triggers the creative process by critical thinking that leads to mastery and discovery learning (**Finding # 7**).

The Coaching Approach Encourages a Non-judgmental Atmosphere

The non-judgmental atmosphere, promoted by *"the coaching exercises, made us so relaxed. I felt that my views were important, the choice of questions and the body language, all the things that were done made me feel so relaxed,"* Mr. Lennox reflected about his seminar experiences (Seminar, Sept 4). He further stated that the "*environment was created for you to feel secure and to just be yourself*" (PD, Oct. 22). Mrs. Scott commented on the comfortable atmosphere generated during the seminars as one that gave voice to each participant:

> *The atmosphere that was created in the seminar was one in which you felt that even if you were objecting or even if you thought you were saying foolishness it was important; it was worth the while saying, and so it gave you that comfort. It was a comfortable situation"* (Group Interview [G. I.], Sept. 22, 1997).

Mrs. Sinclair, also reflecting on the seminars, stated that she had also gained from her experiences and that if similar experiences were generated into the classroom, learning would be enhanced, and students would develop a love for mathematics while encouraging a level of trust. She claimed:

> *I have gained also that in a very relaxed atmosphere in the classroom, the children will develop a love for math. For relaxation to take place, there must be a level of trust, and if you have that, it will enhance learning.* (PD/G. I., Sept. 22)

Being exposed to the *Coaching Approach* during the seminars and beginning to translate his experiences into the classroom, Mr. Lennox stated that the *"teaching atmosphere in the classroom . . . is an invaluable approach*" (PD/G. I., Sept. 22). Mrs. Sinclair stated that she was made more conscious of not only the knowledge she wanted to pass on to her class but the attitudes because the attitudes revealed have an impact on what transpired in the classroom. She claimed:

> *Coaching enhances learning, and it also enhances teaching. Learning is the ultimate outcome, but it enhances teaching. You have to be far more prepared, conscious of what you are going into the classroom to do, not just for the knowledge base but for the attitude. What attitudes you are passing on consciously or unwittingly to the students. You are very conscious of that.* (PD/G. I., Sept. 22)

According to Mrs. Sinclair, the "whole individual" including the recognized links between the cognitive and the affective domains was being taken into consideration. As a result, teaching was being done in a non-compartmentalized way, and conscious consideration was being given to the total developmental aspect of each child. Mrs. Sinclair affirmed, *"I am trying with the whole developmental aspect of the child."*

With the experiences gained from the seminars, coupled with information shared from the teachers' initial translation of their classroom experiences, Mr. Lennox averred that *"It is a good method of teaching."* He also proposed that the *Coaching Approach* might be the path to eliminate negative attitudes towards mathematics:

> *With the experience gained from the seminars in implementing the various strategies, I find that the behavior of the students is being enhanced not only in terms of their attitude but in terms of their performance. Their confidence level has risen to the point where they are not afraid to really go at a problem. So maybe in the future, based on the coaching experience and with the knowledge that we are trying to get across, we might be saying that coaching is going to take away the fear of mathematics. This is a better way to go, and this might be the method.* (PD G. I., Sept. 22)

Mr. Lennox observed that both the students' behaviors and attitudes were enhanced. The students' attitudes were being changed both in their approach to mathematics problems and to the subject because of the level of confidence the approach was promoting. Before employing the *Coaching Approach*, creating a comfortable, trusting atmosphere in the classroom was not a deliberate act for Mrs. Scott. She explained: "*The whole thing of making your class even more comfortable, I think I had a level of it, but it was not deliberate enough to really create a comfortable environment for the children, a trusting one*" (PD, G. I., Sept. 22). However, after embracing the *Coaching Approach*, she made a conscious effort to remove both verbal and non-verbal judgments.

Only two weeks into the school term and using the *Coaching Approach*, Mrs. Scott stated that creating a trusting atmosphere in her class was making a difference. One way she was translating her seminar experiences was by making deliberate attempts to eliminate judgmental words from her vocabulary. She also stated that she was making a conscious effort so that her body language did not convey negative messages:

> *Even the negative messages, concerning either what you say or your body language, but deliberately, consciously, creating that atmosphere in the*

> *classroom, basically eliminating some words from my vocabulary and my thoughts, mentally preparing to go into the class and deliberately taking out some words . . . is making a difference.* (PD G. I., Sept. 22)

She stated that her practice of marking the students' assignments and quizzes was also changing:

> *As a matter of fact, I am marking a little quiz now, . . . and I don't put "X" on the paper; it is either "no" or "you have made this mistake more than once," or something like that. But not just the "X." In other words, I am trying my best not to send across a negative message that would instill fear and make them not want to try. . . . It is that trusting atmosphere that is being created that is making a difference.* (PD/G. I., Sept. 22)

Mrs. Scott realized that trust-building was essential for the removal of fear for mathematics and could be partially accomplished by eliminating judgmental messages in the teaching and learning context. Also, in marking students' scripts, she was no longer reacting judgmentally by "attacking" the person but was treating data objectively that suggested an error in the solution process of a particular problem. She continued:

> *As for our students, . . . even in marking their paper you don't say "dis pickney ya dunce eh man?"* [this child is so dumb!] *"X times X is X - Squared!" What else must I do?" and you are gritting your teeth. Now, in marking you say "You have made a mistake here; what has happened?"* (PD/G. I., Sept. 22)

With approximately twenty-two years of experience in this particular school, Mrs. Sinclair also recognized a change in herself and her classroom experience since the seminars. She stated:

> *I have also learnt to build trust among my students. I see them more as individuals now, and also my colleagues. I think that part has really improved since the seminar. . . . I am trying NOT to be judgmental (laughs). It is difficult . . . but I am trying very much to take out the "NO! Not like that! How could you think like that? Stupid! Rubbish!" You try not to say those terms and things like that, and allow a more freedom of expression . . . "Why do you think like that? Tell me how. Explain to the class," and things like that. But we are trying that more in the group work than in the large group situation.* (PD/G. I., Sept. 22)

Like Mrs. Scott, Mrs. Sinclair said that one of the ways she was building trust and generating a comfortable atmosphere in her class was by eliminating remarks that would convey messages to the students that their opinions were not valued. Instead, she was valuing and respecting student ideas. With the use of more open-ended questions for small group situations rather than in the large class setting, students were encouraged to think and offer their own opinions during discourses. Mrs. Sinclair also said,

> *I have also learnt to build trust among my students and more freedom of expression. . . .They know that when someone else is speaking they cannot say "no you are wrong!" and things like that, . . . and I am learning not to be judgmental, too.* (PD/G. I., Sept. 22)

The *Coaching Approach* also influenced Mrs. Jacobson's approach to teaching and learning in the classroom; she stated that she learnt a lot: *"I have learnt not to be judgmental and many other things"* (I. I., Dec. 4). One of the things Mrs. Jacobson elaborated on was passing judgments about the students' work and *"telling the children directly that 'that is wrong' and 'do not do it that way.'"* The passing of judgments might influence the students negatively, she reported. So *"I have learnt . . . not to shame them in the class."* As a result, *"they are quicker to participate in activities, otherwise, they would have kept to themselves."* Therefore, as a result of refraining from making negative comments in her class, Mrs. Jacobson observed that her students felt more comfortable participating in classroom activities.

These teachers strove to eliminate not only negative messages during their interactive discourses with one another and with their students but also the so-called "positive" judgments as well. Mrs. Scott, while speaking about the atmosphere created during the seminars, concluded that *"it was a comfortable situation, and as a result, . . . I would sum it up by saying it was very good."* Realizing that she used a judgmental term, she laughed and questioned herself, *"Oh what do I mean by good?"* and then she gave a further explanation as to what she meant by "good" (PD/G. I., Sept. 22).

Mr. Lennox, during the October 22 PD session, stated that one of the strengths he recognized about himself in taking on the *Coaching Approach* was, *"I find that I am not being judgmental, especially in the class situation . . . but I have recognized now that I don't judge the students when soliciting information from them. This is one of my strengths."* So while soliciting information from his students in the classroom, Mr. Lennox refrained from passing judgments on students' responses. Again in his December interview, he elaborated on the non-judgmental approach, how it raised his consciousness about the negative effects that even positive judgmental messages might have on hearers. As a result of the conscious elimination of judgmental messages, all his students felt equal in his class; he reported:

> *From time to time I used to say to the students "good," . . . but I find that the non-judgmental approach that coaching seems to have an edge on, cuts down on that. So all my students as it were now feel equal in the class. You see, prior to this experience, I thought more or less when I say "good" or something like that, I would be motivating and encouraging, but yes, I might be motivating and encouraging one person but what was it doing to the other students?* (I. I., Dec. 4)

Mr. Lennox continued to explain that the positive judgmental words might be motivating and encouraging to the students to whom they were spoken, but for others within the setting to whom such address was not made:

> *It was having a negative impact on them. They are saying, . . . "for math class student X is the best and I think of myself as not good enough," . . . and so that whole judgmental approach comes under not being aware. The judgmental approach has totally been replaced by this non-judgmental approach.*(I. I., Dec. 4)

For Mr. Lennox, the practices of a judgmental approach were carried on from time to time because he was not aware of the total implication of the judgmental expressions in the classroom setting. However, embracing the non-judgmental approach or the *Coaching Approach* had totally replaced the judgmental practices as he became more aware. He stated that as a result, his students did not think of themselves as superior or inferior to one another, but felt they were all equal.

The conferencing opportunities in the *Coaching Approach* promoted relationships among teachers as colleagues, which tended to erase judgments. This, according to Mrs. Sinclair, helped tremendously because teachers felt free to solicit their peers' opinions without anyone thinking negatively of the one who solicited the information. She stated:

> *I think it is because we have to coach each other and the non-judgmental part of it. I think the non-judgmental part has created that. Nobody is there judging you saying you should have known that, . . . I think that part, we have taken that part out of it. I think it has helped tremendously.* (I. I. Dec. 4)

Mrs. Scott also stated that the *Coaching Approach "has enhanced communication, and therefore relationships have improved, especially among my colleagues because of the* *whole non-judgmental approach"* (I. I. Dec. 9). She went on to state that former practices *"cultivated a whole environment of judgments, and decisions that you make are always based on some sort of critical evaluation, and so that has changed."* The judgmental approach that they practiced

> *has changed in that you are not so judgmental anymore and the whole Coaching Approach has really erased that. As a result, relationships are better this term more than it has ever been, and you feel you can communicate now on a more social level.* (Mrs. Scott, I. I. Dec. 9)

Mrs. Scott concluded that the *Coaching Approach* changed her attitude: *"It has changed me from my being a judgmental person, being judgmental with my class, with my peers, and the educational system. . . . This holistic approach aids in the development of the whole person"* (I. I. Dec. 9).

The *Coaching Approach* encourages a non-judgmental atmosphere; deliberate attempts are made to remove positive and negative verbal and non-verbal judgmental messages in the classroom setting to develop freedom of expression, enhanced communication, the development of the whole person, and students' willingness to participate in class activities. The *Coaching Approach* promotes a comfortable, trusting atmosphere that leads to improved relationships where individuals feel secure and relaxed and where students feel equal.

The *Coaching Approach* encourages a non-judgmental atmosphere, freedom of expression, and effective communication by the removal of positive and negative verbal and non-verbal evaluative messages from discourses (**Finding # 8**).

The Coaching Approach Promotes Learning by Discovery

Concerning the difference in the nature of the *Coaching Approach*, its internal dynamics triggered structural changes resulting in a discovery approach. The teachers' usual practice of lecturing changed, leading students to discuss, investigate, and share their ideas with one another. Students were encouraged to objectively analyze their own mistakes as well as those of others to stimulate learning in a comfortable environment. Mrs. Sinclair noted:

> *This approach lends itself to be more investigative. It is more student-centered more than teacher centered. The teacher is not there to lecture as such; it is more of a discussion, involvement of the students where they get to share their ideas and opinions; they make their mistakes and find out what their mistakes are and work to improve their whole learning. It is relaxing.* (PD, Oct. 22)

Mrs. Jacobson reinforced this, stating that one thing she learnt from the *Coaching Approach* is that

> *the class should be student-centered. Allow the children to do and work rather than the expository way of teaching—the chalk and talk. It has been helpful; I have been practicing the group work instead of chalk and talk.* (I. I., Dec. 4)

Based on her experiences in accommodating the MLE in the classroom, Mrs. Jacobson elaborated her understanding of student-centered learning:

> *It means that I am not the one telling them everything. They can explain something to you or they can sit in their groups and discover among themselves how to work out a problem rather than me telling them.* (I. I., Dec. 4)

From Mrs. Jacobson's perspective, student-centered learning is allowing the students to work together so they can discover concepts and principles themselves. Mr. Lennox also reinforced this by stating:

> *It is very much an interesting experience because what they are now recognizing is that the power to solve a problem or the ability to solve a problem does not lie with the teacher, but they have the ability to solve any problem. So therefore, within themselves, it is a discovery for them.* (I.I., Dec. 4)

Therefore, recognizing their ability to solve problems for themselves without the help of the teacher is an important element in discovery learning.

Comparing the type of grouping that is encouraged by the *Coaching Approach* with groups in co-operative learning situation, Mrs. Jacobson observed that *"this is better because there are assigned roles; each person participates"* (I. I., Dec. 4). This setting, teachers observed, lent itself to discovery learning and discouraged lecturing. Students, in small groups, were generating thoughts and alternative solution paths for problems as they shared and explored ideas and opinions, drew their own conclusions, and discovered mathematical principles among themselves.

Mrs. Scott observed that her approach to teaching was changing; she was facilitating students instead of lecturing to them. Thus, students had more time for individualized learning in their groups. Relating her experiences of the first two weeks of school to her colleagues, Mrs. Scott reported:

> *I don't have to "teach" so much. . . . Because you allow them . . . they are coming up with very interesting approaches. . . . They are doing their own observation and drawing their own conclusions . . . so you find that I am not spending so much time on the chalkboard, and so they have much more time for exploring in their groups. . . . The fact that I don't have to be talking so much, you have noticed that I have not been hoarse since school started . . . I am not lecturing. ... It is more coaching them in the direction they need to go, and I find that they are going faster than if I were lecturing. Initially, I thought it would be slower . . . and that the whole group thing would really waste our time . . . but they are moving faster.* (PD/G. I., Sept. 22)

Mrs. Scott observed that the setting supported those engaged in exploring concepts because they were synthesizing and connecting disconnected bits of information in their personal mathematical histories, and learning was taking place at a faster rate. This was done as she mediated what students were supposed to be learning. According to Mrs. Scott, although *"they are working on their own"* in their small groups, their time and efforts are maximized; *"They are being creative."* As a result, *"we don't have a disciplinary problem,"* and *"even though all the groups are working, the noise level is not much above what is normal"* (PD, Oct. 22). The group consensus during the October 22 PD session was *"that the stress of telling had been removed"* from teaching. Mrs. Scott explained that *"as a result, I think we are not so stressed out after leaving a class, but we have more energy to prepare and to read ahead"* (PD, Oct. 22). For Mrs. Scott, her classroom role changed from "*telling and directing*" to "*mediating, coaching, listening and redirecting.*" As a result of her changed role, *"teaching had become less stressful"* (I. I., Dec. 9). Mr. Lennox also validated this when he stated:

> *Also, amongst the students we are seeing that this program focuses on a thrust towards strategies has really empowered the students to be working amongst themselves. So it is really joyous to see them not being dependent on the teacher but they stop to challenge any problem, and this warrants the whole benefit from this approach towards even doing their external examination. What they do now is more beneficial than studying on their own.* (I. I., Dec. 4)

Mrs. Sinclair further stated that other professional development activities in her experience focused only on the development of the teachers' creativity hoping they would make the necessary transfer for students' learning. But the *Coaching Approach* maximized students' participation and tended to develop students' creativity as well as that of the teachers (I. I., Dec. 4).

The *Coaching Approach* promotes learning by discovery as students in their groups with defined roles, discover/"uncover" mathematical concepts and principles for themselves as they recognized their own abilities to solve mathematical problems and became less dependent on the teacher whose role shifted from the expository mode toward one of a mediator (**Finding # 9**).

Eliminating Teacher Isolation

I felt that the Coaching Approach eliminated teacher isolation through collaboration and freedom of self-expression.

The Coaching Approach Engenders Collaboration

The collaborative nature of the PDP seminars was designed to help liberate teachers from their isolation by dissolving "walls of separation" that existed prior to the PDP. The teachers reported, "*We never used to sit and talk like this before, . . . this sharing with fellow teachers . . . we never used to do it. We would talk*" (Mrs. Sinclair, PD/ G. I., Sept. 22), "*but as a group, no, this is new*"; Mr. Lennox added. Thus, individualism was being transcended by the dynamic and interactive mode of collaboration inherent in the *Coaching Approach*.

Teachers who participated in the PDP seminars were grouped randomly using strategies that did not make it obvious that grouping was one of the desired objectives to be achieved. Reflecting on the initial experiences of the PDP seminars, Mrs. Sinclair remarked:

> *We did not even realize that we were being placed in groups; we thought that it was just an exercise. We were made to realize that we and the other person had so much in common, and so we learnt so much from the next person through incidental learning.* (Seminar, June 25, 1997)

The enacted experiences seemed as incidental learning for Mrs. Sinclair. The techniques employed for grouping also impacted Mr. Lennox, who reported that "*the very creative ways in which the grouping of the different persons involved was done . . . was excellent.*" Hence, the utilization of the *tool* of grouping as a mode of collaboration served to build the learning communities.

The comfortable atmosphere generated in the collaborative setting brought with it a sharing and pooling of ideas that fostered creativity. According to Mrs. Sinclair, "*We are sharing more in this situation; you might come up with A, and I come up with B, but we all get it together*" (Seminar, June 25, 1997). Therefore, even though their ideas might have been different, everyone's idea was considered important as they all worked together on the same aspect of the particular tasks. The same aspect was viewed from the different perspectives. Mrs. Sinclair further explained, "*Everybody comes together to come up with the solution* (Seminar, June 26, 1997).

The *Coaching Approach* also encouraged team work. According to Mrs. Scott, "*It forces us to work together in all contexts. It forces team work among us as colleagues*" (PD, Oct. 22, 1997). Thus, the space of each teacher's world was being extended to accommodate others through their involvement in the various activities of the Professional Development Process (PDP). Hence, according to Mr. Lennox, "*the interdependence comes in here now, where I am sharing some more and am able to coach my colleagues*" (I. I., Dec. 4). For Mr. Lennox, collaboration led to interdependence as the opportunities to share in the conferencing sessions were provided. Mr. Lennox further explained the helpfulness of the collaborative process:

> *Sharing with my colleagues and they sharing with me, I find that very helpful. I have found that on a number of occasions the suggestions that I have used came from my colleagues and have really helped to a great extent. The fact that I was not thinking in that light, using it in the situation has helped.* (I. I., Dec. 4)

Sharing during the collaborative process extends one's repertoire; thus, it was a helpful process to the individuals involved. Mrs. Jacobson also elaborated on this by stating that "*The approach . . . helps me to prepare for every class. . . . Apart from preparing, I am* *ready for my class.* She continued to explain the impact of the collaborative process in preparation for her classes:

> *The fact that you know what you are going to do before class, . . . this approach has made me a little more confident as a teacher. . . . I am sure of what I am doing now. I am confident in myself. . . . The coaching makes me more prepared. I know precisely what I am going to do, what approach I am going to take, . . . how I am going to do it. . . .* (I. I. Dec. 4)

Mrs. Jacobson also stated that, as a result of this approach, she was *"feeling more comfortable with the teachers in the department than previously."* The reason she offered for feeling more comfortable with her colleagues is

> *we never had the opportunity to meet and to coach each other. We have never done it before. We have meetings as a department yes, to plan for our classes, but not in this way. . . . Well, what we are doing now with the Math Learning Approach is that we guide each other; we coach each other.* (I. I., Dec. 4)

Mrs. Scott also acknowledged that although they were in the same working environment for so many years as teachers, they did not really know each other. However, the *Coaching Approach* led to a transformation of relationships to the point that the formality that existed was being eroded: she was now using first names in referring to her colleagues. She felt the actions of colleagues were no longer misinterpreted as opportunities for working together were created. Mrs. Scott further reinforced this point:

> *Being here for so many years, we just did not know each other really. . . . But because now you share and you talk, you are not as judgmental as before. Therefore, if the person does X, you don't have to think it is X-squared. It is just simply X, and so the whole judgmental assessment thing is going . . . Just working together, you somehow get a better understanding of your colleagues. Honestly, it really sort of just triggered something off in me, in a more positive direction* (PD/G. I., Sept. 22, 1997)

Mrs. Scott stated that moving from working in isolation to working collaboratively was transforming for everyone: *"It is transforming for myself and my colleagues, for the opportunity just to work together"* (PD G. I. Sept. 4). She explained that the experience was *"transforming in the sense that you can now have your colleagues in the classroom just watching and working together."* The conferencing opportunities inherent in the *Coaching Approach* provided collaboration whereby each teacher guided another through the teaching/learning process. For Mrs. Jacobson, "*the coaching is very important,*" and "*also the reflection*" (G. I., Dec. 5). Mrs. Jacobson continued:

> *To me the coaching is most important . . . because before you teach a class, the teacher is guided by another teacher as to what steps you are going to take or what approach you are going to take. . . . The coaching brings out the methodology for me.* (I. I., Dec. 4)

For Mrs. Jacobson, the methodological stance emerged as one was engaged in the collaborative process inherent in the *Coaching Approach*. Mr. Lennox emphasized that "*all in all, this has really contributed to a higher level of efficacy.*" As a result of the process, "*I am becoming more efficacious. . . . I am more flexible, I am aware, I share with my colleagues, and my craftsmanship has improved.*" Mr. Lennox stated that, for him, "*teaching has become even more real and much more practical*" (I. I, Dec. 4)

The *Coaching Approach* eliminates teacher isolation through collaboration; transforms relationships by generating better understanding between and among teachers, and enhances teachers' states of mind as the opportunities to share as a group and to coach one another promote team work (**Finding # 10**).

The Coaching Approach Promotes Freedom of Self-Expression

The collaborative nature of the seminars and the occasions for sharing during PDP and MLE encouraged teachers to be open to suggestions and ideas and to appreciate their own commonalties and differences. A trusting, collaborative climate was created as participants were encouraged to express themselves without reserve. Mrs. Scott observed:

> *You are forced to open up, and you are forced to let down your guard. In doing so, you open up and you are not afraid to expose yourself. It was not a matter of being afraid if you were right or wrong; you were just open. I think just bringing in the non-judgmental atmosphere that was strengthened in the workshops helped.* (Seminar, October 22, 1997)

Sharing in a non-judgmental, non-evaluative atmosphere allows one to be open to suggested alternatives. No value judgment was intended to be placed on any response during collaboration, and respect for each person's input was encouraged during each sharing process throughout the PDP. The *Coaching Approach* lent itself to a comfortable trust-building situation as no intimidation through verbal or non-verbal messages was intended to be conveyed. Reflecting on the three-day June seminars, Mrs. Sinclair noted that one of the things that stood out to her was

> *the freedom of oral expression. We were able to express ourselves in a very comfortable atmosphere, and sometimes in the classroom we as teachers do not have that open-mindedness. By our body language, we shut up the child. The child wants to say something, but we stop him, but in this seminar we realize from our experience that we can learn so much from the child if the ideas that he has he is able to share orally without anyone's being judgmental.* (Seminar, June 25, 1997)

Reflecting on the June seminars, Mr. Lennox stated, "*The environment was created for you to feel secure and just to be yourself. Whatever you are saying, there is no one to tell you that . . . your idea is not necessary or not important*" (PD G. I., Sept. 22). The atmosphere generated during the seminars allowed each individual to feel unique and respected. It created a setting for acceptance, a feeling of security, freedom of expressions, and the explorations of thoughts and promoted spontaneous thinking for the generation of *Discourses* in the various situations. Reflecting on a particular experience during the seminar, Mr. Lennox noted: "*I did not know that . . . I could think so quickly on the spot, but the relaxing atmosphere that as a coach . . . you created helped me to respond very freely and positively* (Seminar, June 25, 1997). The comfortable atmosphere of the PDP seminars generated a positive climate, helped individuals experience a feeling of acceptance by everyone, and led to a willingness to share. According to Mrs. George,

> *If there is a comfortable situation between teacher and students, there will be openness; they will be free to say what they want to say; their self esteem will be improving, and they will feel accepted and willing to share.* (Seminar, June 25)

Projecting her thoughts on what could result from a trusting relationship between students and teacher in the classroom, Mrs. George seemed to be reflecting on her own seminar experience. During the seminars, as teachers took turns sharing their ideas, initially Mrs. George would not volunteer her thoughts. Even when called upon, she would say that someone else expressed what she wanted to say. Eventually, Miss Zanti, who sat beside her, took the paper on which she jotted her ideas and shared one particular idea. I did not make any judgmental comments about her idea, but accepted it for what it was worth. I felt that this led her to feel that her idea was valued. I commented on the particular idea as the next issue to be explored, as it was the foundation for any communication network. Mrs. George took the sheet of paper from her colleague and started sharing her other ideas freely (Video-tape, June 25). I never had to prompt her again to share her ideas; she volunteered them.

Mrs. Scott also expressed her comfort about the seminars:

> *I felt good about the seminar because it was one in which everybody could participate. As you said, our input was just as important as the presenter's input. The atmosphere that was created in the seminar was one in which you felt that even if you were objecting, or even if you thought you were saying foolishness it was important; it was worthwhile saying, and so it gave you that comfort. It was a comfortable situation.* (PD G. I, Sept. 22, 1997)

The collaborative nature of the PDP seminars helped create an ambiance that empowered participants to express their thoughts freely. Everyone had a voice and was heard. Everyone's ideas were valued and respected.

The *Coaching Approach* promotes freedom of expression and development of interactive *Discourses* through the generation of a trust-building, secure, relaxing, and collaborative environment as no value judgment was placed on individuals' ideas as teachers participated and felt safe to express and explore their thoughts and ideas because they were respected and valued (**Finding # 11**). Miss Zanti read from Mrs. George's paper: "*Students need to trust teachers in order to feel comfortable*" (Seminar, June 25). Trust is the foundation for a comfortable climate and engenders openness and sharing.

The Establishment or the Erosion of Trust

The *Coaching Approach* engendered trust. While reflecting on the comfortable, trusting atmosphere generated from the context of the PDP seminars, teachers stated that when trust exists in a relationship they feel: "*comfortable,*" "*relaxed,*" "*confident,*" "*happy,*" "*excited,*" "*motivated*" "*secure,*" "*accepted, and loved.*" "*All fears are gone*"; "*there is willingness to share ideas; there is no need for secrecy; there is* *openness for discussion, encouragement, and criticism";* and *"one is no longer shy."* According to Mrs. Sinclair, *"self esteem peeks to its zenith,"* and Mr. Lennox stated that he felt *"energized"* when trust existed (Seminar, June 24).

Refraining from the passing of judgments fosters the building of trust. The *tools* of *Coaching Discourses,* including the conferencing structure—the planning conference, classroom observation, and reflecting conference—provided the opportunity for building, establishing, and sustaining trust. This took place in the collaborative relationships as the non-judgmental techniques were adhered to. According to Mrs. Sinclair, *"trust takes time to develop,"* while the passing of judgments is a key factor in the erosion of trust. When trust is eroded and judgments are introduced into a relationship, *"You are always suspicious of the next person . . . the moment trust is not there"* (Seminar, June 24).

During the term, while I was relinquishing my role as coach, and because the new timetable did not allow for natural coaching dyads for each teacher, we tried various ways to overcome the difficulty of not having coaching dyads for every teacher. For one of Mr. Lennox's double session classes, Mrs. Scott was free for the first session, so a planning session with Mrs. Scott and Mr. Lennox was set up. Mrs. Scott, the coach, told me that after observing Mr. Lennox for this first session, she made certain comments to him. This, I perceived, ended this particular coaching dyad before it even got started.

The coachee, Mr. Lennox, after having outlined his plans for the class during the planning conference, incorporated suggestions made by Mrs. Scott. However, during the lesson observation, it was apparent to Mrs. Scott that he did not follow through with the student involvement aspect he planned; instead, he utilized direct teaching. Instead of waiting until the reflecting session to address the particular issue in a non-judgmental way, Mrs. Scott remarked to Mr. Lennox that probably if he were being evaluated by any teacher's college tutor, he would have received an "A" for his teaching. This, she stated, was done excellently; however, if the lesson had been done as originally planned, more student learning would have taken place. Mrs. Scott did not suspend her judgments until the reflecting conference, which might have resulted in Mr. Lennox's making a similar deduction (Notes, October 14).

Even though these teachers were good friends outside of class and had good rapport, Mr. Lennox did not turn up for the next planning conference with Mrs. Scott as had been planned. In fact, he did not turn up for any further coaching session with her but gave excuses such as having other things to do at the planned times for conferencing. He was even hesitant to attend the October 22 monthly meeting. Prior to this, however, Mr. Lennox had met with me for his conferencing sessions on time. I felt that the judgmental comments caused him to withdraw and, as a result, this withdrawal interfered with the establishment of a functional coaching dyad. As a result of this disruption to the forming of a coaching dyad, we sought to have alternate dyads formed; these were never disrupted.

Trust exists when a comfortable atmosphere is generated; when positive feelings of openness and willingness to share are encouraged; on the other hand, trust may be eroded when judgments are made (**Finding # 12**).

Transformation as a result of the Non-Judgmental Context of the Coaching Approach

Prior to this study, some teachers stated that whenever someone visited their classes, it was for evaluation purposes. They shared that this led to anxiety on the part of the person being observed and triggered questions such as: "Am I good enough? Am I doing right?" Nervousness then set in because the teacher being observed was not aware of the reason for the particular class visit. They also remarked that they were never made aware of what specifically was being observed. Naturally, in the evaluation of teaching, judgments were made, and this did not engender trust between those who were involved. According to Mrs. Jacobson, prior to the *Coaching Approach*, students would "*clam-up*" even when they were "*good*" at something, and she also experienced high levels of anxiety when her classes were visited by others (I. I., June & December, 1997).

However, having had the opportunity to work together, teachers experienced a change. Mrs. Scott observed: "*It is transforming for myself and my colleagues, for the opportunity just to work together*" (PD G. I. Sept. 4). She further explained that the experience was "*transforming in the sense that you can now have your colleagues in the classroom just watching and working together.*" Having fellow teachers and me sit in their classes, teachers felt they were not intimidated anymore, even by unexpected visits of the principal. Mrs. Scott affirmed:

> *Even when Mr. Dyer stepped in (laughter) I was so engrossed in my coaching, I was not even aware at first that he was there. And by the time I found out, it would not have made any difference so I just carried on. But the whole coaching thing made the difference because of what it did for me. Because if I were probably on the board and he walked in and listened, I would be paranoid. But because you are there with the students mingling and explaining, he gave a suggestion for a particular point in a problem, but I just went on. The whole thing of the sort of fear, not that I was afraid of him, but mentally the coaching really makes you feel as if you are in charge of the class, and you know really know what you are doing; . . . it is just OK.* (PD G. I., Sept. 22)

Mrs. Scott was able to accommodate external views and suggestions even from the administrator who previously, by his mere presence, would have instilled fear during his visits to the classroom. According to Mr. Lennox, as teachers, they were not only incorporating principles *"but also you see more of the empowering aspect coming into it from the Math Learning Approach, more empowering of teachers and students"* (I. I. Dec. 4). Therefore, the fear that teachers usually experienced when someone visited their classroom was no longer there. Teachers felt in command of the teaching and learning situation.

The non-judgmental context of the *Coaching Approach* transformed relationships in the entire mathematics department. According to Mrs. Scott:

> *Relationships have improved, especially among my colleagues because of the whole non-judgmental approach and attitude. As HOD* [Head of Department], *it is sort of built in; as a matter of fact, we were taught that this is how . . . you manage your department; you are firm, giving criticisms, sometimes positive and most times you are definitely looking out for the negatives and pointing them out because that is your job, . . . and so that has changed; . . . and you are not so judgmental anymore because the whole Coaching Approach has really erased that. As a result, relationships have been better this term, more than they have ever been.* (I.I., Dec. 9)

This transformation also impacted Mrs. Scott's views of formal teacher evaluation. Annually, written summative evaluations have to be submitted to the Ministry of Education; however, Mrs. Scott was considering an alternative form of evaluation for the mathematics teachers at Dominion High. She acknowledged:

> *Usually in evaluations, you have to be looking at how persons are performing on a certain scale, and therefore it cultivates a whole environment of judgments, and decisions that you make are always based on some sort of critical evaluation. . . . Now for the evaluation, I am thinking of making it a combined thing that is not based on my judgment but more how the person actually sees himself or herself performing or has been performing.* (I. I., Dec. 9)

The *Coaching Approach,* according to Mrs. Scott, was replacing the previous judgmental approach. She emphasized that teachers within the department were now operating "*on a more social level,*" not doing certain things because they were told, but because they were now a way of life. Mrs. Scott emphasized that taking on the *Coaching Approach* was not robbing her of her "power": *"It is not taking away from my responsibility as HOD. It is not creating havoc in the department that you don't know where to draw the line, or it is not that simple instructions are not being followed anymore."* Neither was anyone being laissez-faire. However, *"That which the judgmental and critical approach was supposed to accomplish, you find that taking that out and replacing it with the non-judgmental, . . . more mediatory, coaching, listening, and redirecting instead of telling"* was also allowing for a smooth flow of events. *"So whereas, people are not just carrying out instruction now because they are told to but because it is more of an agreement, . . . things are flowing much better"* (I. I., Dec. 9).

Mrs. Sinclair also attributed the transformation taking place to the process they were involved in:

> *I think it is because we have to coach each other and the non-judgmental part of it. I think the non-judgmental part has created that. Nobody is there judging you saying you should have known that. I think that part we have taken out of it. I think it has helped tremendously.* (I. I. Dec. 4).

Mrs. Sinclair also stated that her students were now everybody else's students and vice versa. If a teacher were absent from school, she would invite the teacher's students to join any other teacher's class without the class's teacher feeling that he or she was being imposed upon. Prior to this experience, students would be sent to the library or told to do some work on the concepts last taught. She stated, "*We are much more caring now, not only for each other but also for our students.*"

The *Coaching Approach* brought about a transformation from a formal, individualized, and isolated world to one that manifested itself in professional understanding and caring, in the building of trust, and in empowering teachers to be in command of the teaching and learning context (**Finding # 13**).

Summary

In light of the findings outlined in this chapter, the research question will now be re-addressed, *"How was the Professional Development Process (PDP) utilizing the vehicle of cognitive coaching perceived and accommodated by teachers of mathematics in the Jamaican context?"*

Initiatives that engender change cannot run by themselves. Involvement of the administration was important as the group took an active role in planning. The principal's role in generating a culture for the accommodation of PDP was crucial. Redesigning the school timetable and the rethinking of scheduling to support teacher learning could not have taken place without the support of the administration.

The *Coaching Approach* allowed teachers to "embrace" principles and concepts needed for the enhancement of mathematics learning. Participants viewed the *Coaching Approach* as an approach, not a method. This approach can be utilized for the teaching and learning of any topic, in any subject area, and at any grade level. It increased the engagement of teachers and students; it allowed them to reflect on the history of their mathematical experiences, synthesizing, coordinating, and extending them to form a whole. It redirected their thought processes to explore alternatives; taking them beyond rote and mechanical knowledge to deducing concepts and processes while utilizing the dynamic modes of collaboration through team work to create a new climate for learning by understanding.

The *Coaching Approach* is a reflective approach. It evokes alternatives and demands reflection that triggers assimilation and accommodation for one to make meaning. The uncertainty of how the initial Cognitive Coaching experiences would be translated into mathematics classroom practices triggered reflection on what was being valued, internalized, acquired, and anticipated. It also generated "wondering ifs" the teachers' thoughts were projected onto the desired goal.

The universality of the *Coaching Approach* allows for a broadening of pedagogical horizons as one moves beyond mere knowledge of teaching and learning to educe latent principles and concepts through experiencing. The *Coaching Approach* enhanced not just teaching but learning. It encouraged teachers to view learning in a more holistic way as they considered both the affective and cognitive domains in a setting that allowed for exploration. Teachers prepared thoroughly as they utilized the trust-building tools for their classroom teaching and learning experiences. Utilizing the trust-building tools led to flexibility and openness among teachers. Thus, they learnt from their students. Their own behaviors as well as that of their students were enhanced.

The *Coaching Approach* is a learner-centered approach that facilitated students' learning as structural changes in the mode of delivery occurred to allow for discussions, investigations, and the sharing of ideas. As a result, students were a source of the generation of thoughts which promoted the understanding and connection of concepts and principles. As students were engaged, teaching was made less stressful, the noise level was acceptable, and lesson planning became more meaningful and worthwhile for all participants.

The *Coaching Approach* emphasized collaboration and eliminated teacher isolation. It encouraged team-work through the use of grouping techniques which made learning seemed incidental. It provided the setting for sharing ideas while working collaboratively on the same tasks. The opportunities to share revealed alternative solution paths to problems. The occasions for sharing in a non-evaluative setting generated a comfortable and safe environment which allowed the *Coaching Approach* to generate reflections on the *Coaching Discourses.* This reflection permitted freedom of expression, as participants were able to let down their guard and express themselves freely. Individuals and their ideas were valued and respected. Reflections provided elaborations and added dimensions to the teachers' experiences. Reflections also engendered collaboration and trust in larger communities while trying to eliminate the passing of judgments.

Through the *tool* of conferencing employed in the *Cognitive Coaching Approach*, the coach guided the coachees through problem situations. Conscious deliberate attempts were made to eliminate verbal and non-verbal judgmental messages from discourses in order to establish trust and rapport in the teaching and learning environment. Teachers were empowered to take charge of the teaching and learning situation. They were empowered both inside and outside the classroom, resulting in transformed relationships between and among colleagues and students. Thus, the walls of separation were removed to allow for a more professional caring and understanding community of learners.

Cognitive Coaching, as a vehicle for professional development, led to the generation of the *Coaching Approach*, which empowered teachers and students to learn by understanding as greater levels of communication were engendered during the discourses in the regular mathematics classroom.

CHAPTER FIVE[4]

THE GENERATION AND DEVELOPMENT OF THE MATHEMATICS LEARNING PROGRAM (MLP)

> *I am thinking that having introduced the topic and whatever the concept is that we want to teach, we could then give the problems to be solved. Based on the information given, the problems would be done within the groups. Each member of the group would be involved in the solutions of the problems so you would have eight groups of five. If there is any particular question that cannot be resolved within the group situation, you, the teacher, would have to respond to just eight persons – maximum—as opposed to 40. It increases the utilization of the skills within the group, and frees you up as a teacher to more effectively answer or deal with the problems that arise.* (Newell, Seminar, June 25, 1997)

This chapter begins with an overview of the *tools* of *Cognitive Coaching Discourses*—the salient elements of the *mathematics learning program* (MLP); then the case study of one of the four teachers' experiences with her classes on the *mathematics learning program* (MLP) is presented. This case includes one teacher's initial cognitive coaching conference experiences, her initial translation of the *professional development process* (PDP) experiences, her accommodation of the *mathematics learning experiences* (MLE) in her classes, and her classes' perception of their MLE. This chapter serves as a partial answer to the research question: *"What were the teachers' and students' perception of the generation and development of the Mathematics Learning Program (MLP)?"*

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a. A version of this chapter has been prepared as part of a paper presented at the April 1998 American Educational Research Association Annual Meeting, San Diego, California, U.S.A., and has been published. Mclymont, E.F. & da Costa, J. L. (1998). ERIC Document Reproduction Service ED 420 637

b. A version of this chapter has been prepared as part of a paper presented at the 1998 International Multicultural Conference University of Alberta, Canada, and has been published. McLymont, E. F. (1998). International multiculturalism 1998: Preparing together for the 21st century, pp. 236 - 250.

c. A version of this chapter has been prepared as part of a paper presented at the 3rd African Society Conference 2000: Prospects for an African Renaissance. University of Alberta, Edmonton, Canada. February 2000.

Tools for Cognitive Coaching Discourses

The PDP seminars dealt with concepts, processes, and techniques in *cognitive coaching* and *Discourses*. These concepts, processes, and techniques were enacted as learning took place as a result of participating in the seminar activities and reflecting on the experiences. The setting for the seminars empowered the community of teachers as non-judgmental verbal and non-verbal trust-building *tools* for *Cognitive Coaching Discourses* were employed in a collaborative environment. This was the beginning of a move away from the current teacher-dominated mode of instruction.

As teachers engaged in whole-group discussions, they constantly reflected on the experiences they had during the activities and projected their thoughts about how the experiences could be applicable in the mathematics classroom. The recurring questions throughout the seminars were: *"How will we incorporate these techniques in a class of 40?" "How can we in a class of 40 cater to this kind of learning?"* and *"How will these innovative techniques enable us to finish the CXC syllabus* [program of studies]*?"* As the situatedness of the occasion triggered these thoughts, the reflective sessions seemed to naturally address the question: *"How were these experiences going to be translated for the teaching and learning of mathematics in the regular classroom?* Suggestions for the puzzling question of how we would apply these techniques in the mathematics learning context were brought forward as individuals voiced their thoughts about the following *tools* that they considered salient.

Grouping in a Collaborative Setting

On June 25, the second day of the seminars, I decided that I would not put off addressing the recurring question of application any longer. So with the six teachers who were present, we explored the question: *"How could we in a class of 40 incorporate these techniques in a mathematics lesson?"* Teachers drew from the experiences of their personal histories in the classroom to serve as launching pads while they pooled their ideas and incorporated the experiences they had been exposed to during the *professional* *development process* (PDP). Mrs. Sinclair stated: *"You could prepare a set of questions,. . . . and have your grouping and activity sheet."* Beginning with the suggestion of preparing a worksheet with a set of mathematical problems to be solved, Mr. Lennox added: "W*e could have groups of about five*."

As I mediated for what would take place in the groups and whether the solution would be reached by just one person or all persons within the groups, Mr. Newell, building on these ideas and reflecting on the experiences of the seminar, stated that solutions for the particular problems could be generated by members of the groups, while the class-teacher would be free to address questions that could not be resolved within the particular groups. He explained:

> *I am thinking that having introduced the topic and whatever the concept is that we want to teach, we could give the problems to be solved. Based on the information given, it would be done in the group basis. The different members of the group would be involved in the solutions of the problems so you would have eight groups of five. If there is any particular question that cannot be resolved within the group situation, you, the teacher, would have to respond to just eight persons—maximum—as opposed to 40. It increases the utilization of the skills within the group, and frees you up as a teacher to more effectively answer or deal with the problems that arise.* (Seminar, June 25, 1997)

Mrs. Sinclair added that *"I think within the group you will need some clear directives and instruction."* Revisiting her experiences of working in dyads during the seminar, Mrs. Sinclair explained:

> *Even when we were coaching, I would say something and the other person would say another thing, especially when we were working in pairs. We were right! But I would help him with this, and he helped me with another.* (Seminar, June 25, 1997)

According to Mrs. Sinclair, each participated in the group activities and was able to express independent ideas about particular aspects of the given tasks. She further stated that the students would *"have to have specific roles."* Reflecting on their own experiences during the seminar activities but without deciding on the group size, the teachers decided that the assignment of specific roles as an extension to grouping was important to bring about maximum participation. Mr. Lennox suggested that one role could be that of *"a recorder."* Mr. Newell had also raised the point that this grouping approach might maximize students' participation and might make "*teaching*" less burdensome for the teacher.

Mrs. Sinclair raised the question about those who might not want to work with others because they might prefer to work by themselves. Mrs. George and Miss Zanti also stated that many of their students refused to work with other classmates. Mr. Sloley cited this as a need for each teacher to explore to find out, "*why is it that many of them say that,*" the reason he gave was "*our experiences might be different.*" This was further explored in the context of the seminar experiences. Mr. Lennox expressed the need to build "*trust and rapport*" among students to help them feel secure in the context and to help them recognize that "*everybody's ideas are important.*" Mrs. Sinclair added: "*When we don't trust . . . we will never get anywhere because I am not trusting you and you are not trusting me.*" Hence, the suggestion for building trust and rapport was considered important for the students to function effectively in their groups.

Reflecting on their seminar experiences, Mrs. Sinclair stated that with the type of grouping that they had been experiencing, they were sharing more. Also, although each individual might have a different suggestion for the solution of a given problem, each person's method of solution enhanced the other person's repertoire, but they all worked together to come up with the solution or solutions. It was concluded that everyone's contribution to the solution process of any problem was integral. Mrs. Sinclair further stated that, as a result of this approach, there was "*more sharing*" (June 25).

Teachers were given the lead: "I want to remember," for them to think about elements of the seminar experiences that were significant to them. Mrs. Sinclair noted the concept of collaboration. This was an added dimension for her. From her experiences in the PDP seminars, she noted: "*I remember co-operative and collaborative learning. That was the only thing I thought about last night. The difference between the two*" (June 26). When asked what the difference was that she understood, Mrs. Sinclair stated:

> *In collaborative learning, everybody comes together to get the correct response or come up with the solution; however, in co-operative learning it is more individualized. Each person comes up with a different aspect of the solution, . . . that is more the co-operative learning, but in collaborative learning we all pool together and come up with this finished product.* (Seminar, June 26)

Mrs. Sinclair noted the extension of the idea of co-operative learning to collaborative learning that was discussed previously. She noted that each individual within a group worked on the same parts of a problem together and pooled their different perspectives while each was assigned a role.

Collaboration through grouping with each individual assigned a specific role allowed for the sharing of different perspectives toward the solution of problems, led to an increase in the utilization of the knowledge and skills each person brought to the learning situation, served as a basis for building trust, and might free the teacher from the act of lecturing (**Finding # 14**).

The Questioning Technique

The questioning techniques employed during the seminars helped teachers voice their opinions and feel relaxed in the setting. They also felt that their ideas were important and that "*The kinds of questions that were . . . asked, . . . forced you to think*" (Mr. Lennox, June 25, 1997). As the activities were enacted during the seminars, higher levels of thought were tapped: analysis, synthesis, and application were brought into play constantly. Hence, teachers felt the need to build their own questioning repertoires.

Mrs. Sinclair wondered why three or four year-olds learn so fast and so well on their own, but when placed in a formal classroom, "*It is as if something snapped; it is so different. The level and speed of learning . . . cut.*" Mrs. Sinclair continued:

> *I think we should have a workshop or something to develop our technique for questioning. Because as teachers, I don't think we have that sort of technique. It is like a lawyer who would know what sort of questions to ask to get certain information. So for this method to work, our questioning bank should be broad; it should be a reservoir, unlimited!* (Seminar, June 25, 1997)

I invited teachers to examine the kinds of questions that were asked by small children as we further explored questioning. Expanding on the nature of the questioning technique as employed in the particular situations, Miss Zanti noted: "*It is not that you are just asking a question for questioning sake, but you are focused on what the person is* *saying"* (June 25). Some questions were generated as a result of one's focus on the content shared by the speaker. This focus generated further probes. Mrs. Sinclair, recalling with humor her experience with her coaching partner, Mr. Sloley, stated that she really liked the probing, but her coaching partner did not like it because he was uncomfortable about what she would ask next. From the employment of the techniques involved, Mrs. Scott also recalled:

> *When asking questions, one should give enough time to the person that is being asked to think about his or her response before answering. Therefore, you don't rush the answer but give the other person the chance to think before responding. And even after responding, don't be too quick to give an answer but you should have a wait period—a pause—between answers and questions.* (June 26)

Mr. Lennox, projecting his thoughts to the classroom situation, stated: *"I will try as much as possible to use the questioning technique, because I really don't like to tell students. . . . Therefore, I must mention that we might have to find a way to finish the syllabus using questioning"* (June 25). Mrs. Sinclair queried, *"Is this the Socratic method where the child knows but you are pulling it out of the child?"* (June 25). The questioning technique as a means of educing information from an individual might be the major means to be employed in the classroom setting.

A questioning technique that impelled thinking, generated probes and incorporated wait-time may serve as an alternative to "telling" in the teaching and learning situation because it allows enough time for reflection and processing of information and signals respect and faith in the person's ability to respond effectively to the cognitive task at hand **(Finding # 15)**.

Paraphrasing

Mrs. Scott stated that the *"meaning I got from paraphrasing is that it shows the ability to listen intentionally"* (June 26). Miss Zanti's assertion served as reinforcement; she stated: *"It shows that you are paying attention; you are listening"* (June 25). From the experiences participants were exposed to, it was deduced that paraphrasing encourages intentional listening on the part of the coach and gives the person speaking *"an opportunity to hear what he or she had communicated . . . and to clarify something* *that he said or she did not say"* (Mrs. Scott, June 26). To verify this point, Mr. Lennox, in his role as coach, stated: *"I have an example here, because I asked her a question and she gave me a response, but because I paraphrased, I was able to understand that that was not what she meant"* (June 25). Mr. Newell added: *" Paraphrasing is basically for validation, and to keep the conversational flow spontaneous. . . . It serves to verify that what the person said was what the person actually meant in response to the question"* (June 25). It was concluded that paraphrasing as a tool serves as an opportunity to hear one's own thoughts and to provide clarity and veracity of the intended messages as well as their interpretation.

Thinking about the use of paraphrasing in the classroom, Mr. Sloley acknowledged that he could see the need for paraphrasing: *"When a child makes a response, you need to clarify what is said by paraphrasing it to make certain that what the child said is what is meant"* (June 25). Mrs. Sinclair reinforced this by stating, *"You have to paraphrase sometimes for you to understand that what the child is saying is what he or she really wants to say"* (June 25). Participants felt that clarification of intended messages contributes to building trust, as the message sent says that the ideas voiced are worthy of further exploration. Paraphrasing was emphasized as essential for this new approach in the classroom because, according to Mrs. George, *"What we are doing here is . . . relating it to what will happen in the classroom."* It was pointed out that often in the classroom, students would often walk away in frustration from a teacher after trying unsuccessfully to communicate certain ideas but were misunderstood; however, paraphrasing may help the child to be understood.

Paraphrasing also seems to mask the next question, according to Mrs. Sinclair. Referring to her coaching partner during a particular activity, she stated that *"Mr. Sloley said when I paraphrase, he does not know what I am going to ask next."* Even though he is anticipating the next question because he does not have a clue as to what the next question is, it puts him on the spot and *"he does not like to be put on the spot"* (June 25). Paraphrasing helps keep the different levels of communication going and demands giving complete attention to the speaker. According to Mrs. Scott, *"It shows that ability . . . not just listening to the verbal, but watching the person's body language* "(June 26).

Paraphrasing is listening intentionally and communicating what is understood. It serves the purpose of validation and clarification and leads to the next question (**Finding # 16**).

Body Language

Mrs. Sinclair posited that body language is "*how we communicate with our body, the gestures*." Also, the subconscious mirroring of body movements conveys messages. It is therefore imperative for the teacher to be aware of body language. "*Body language speaks volume,*" according to Mrs. Scott, (Seminar, June 26, 1997) and therefore should be considered when one is in the classroom.

During the September seminars, Mr. Lennox reflected on the experiences of the first phase of the June seminars and noted that the teachers were able to accomplish what they did during the June seminars because of the non-judgmental "tools" employed in the *Cognitive Coaching Discourses*. He stated:

> *The nonjudgmental activities that were done including the questioning techniques both on paper and whatever exercises we were involved in—the coaching exercises—made us so relaxed. I felt that my views were important. The choice of questions, and the body language, all the things that were done made us feel so relaxed.* (Sept. 4, 1997)

Appropriate body language contribute to the creation of a relaxed setting.

Therefore, the trust-building tools of *Cognitive Coaching Discourses* that included grouping in the collaborative setting with the assignment of specific roles, techniques in questioning including wait-time, paraphrasing and probing, and body language were considered important cornerstones of the MLP because they generated trust, rapport, and effective interactive discourses in the teaching and learning context (**Finding # 17**).

Informal Employment of The Non-Judgmental Approach

To learn interpersonal skills, one needs opportunities and time to experience and utilize these skills in a particular context. The time between the first series of seminars and the next (the entire summer holidays) allowed teachers the opportunity to forget what was not meaningful to them, to begin to employ what was meaningful, to opt out of the study, or to continue. (The teachers of Jerusalem High chose to opt out of study, and so they did not participate in the second phase of the seminar series; however, the richness of their experiences that they brought with them to the seminars coupled with their interpretation of those experienced during the seminars was a vital contribution. Hence, their contribution to the generation of this program was vital). The summer holidays also allowed teachers opportunities to employ in the informal context of their home what they valued from the seminars. This hiatus also afforded them opportunities to reflect and identify the extent to which they had embraced the concepts involved in the *Cognitive Coaching Discourses*. It also provided them an extension to learning experientially. Teachers stated that, during the holidays, they were utilizing some of the trust-building *tools* with their families. This employment led to improvement in communication. According to Mrs. Scott,

> *Paraphrasing is my weakness; I try to listen more now and make sure there is clarity. I am still working on it, at least my husband says I am improving. He insists that that is why I don't tend to have friends, . . . but the more I hear this now, the more I realize the problem. I always ask "Why? You just want an answer," but realizing the whole communication process now makes a difference. I am learning to communicate more.* (Seminar, Sept. 4, 1997)

Mrs. Scott identified paraphrasing as her weakness in the communication process. However, she was listening more and ensuring clarity of what was being communicated. She stated that she was working on improving her use of the techniques, and her husband verified that she was improving her communication skills because, initially, she was used to just providing an answer to whatever was solicited. However, being exposed to the *tools* and realizing how they contribute to the whole communication process, Mrs. Scott stated that employing them was making a difference for her because she was learning to communicate more effectively.

Mrs. Sinclair also shared her ideas about her informal employment of the *tools*. She was listening more, was providing her children with the opportunity to talk more, was learning more about them, and was not imposing her opinion on them. She stated:

> *As a mother, instead of sometimes imposing my opinion on my children—these are my biological children—I listen more and make suggestions. Thus, I am giving them the chance to talk more, to hear how they are thinking, and to learn their thought processes. Somehow you see the cobwebs; what they don't like; what they dislike; what they know; and things like that.* (Seminar, Sept. 4, 1997)

Mrs. Scott and Mrs. Sinclair utilized what they had embraced during the June seminars in their homes during the summer holidays. They listened more and gave more voice to those who tried to communicate with them. They were also able to identify the weaknesses in their modes of communication and sought to begin to remedy these defects.

The time between the seminars series provided teachers with the opportunity to begin to employ in an informal setting some of the *tools* they were exposed to during the seminars, to begin to recognize their weaknesses in the communication process, and to begin to remedy these weaknesses (**Finding # 18**).

The Teachers' First Exposure to the Cognitive Coaching Conferencing Cycle

Reflecting on their experiences with the *tools* for *Cognitive Coaching Discourses* during the professional development seminars, teachers noted that the additional *tool* of structure was imperative for the generation of a similar non-judgmental culture in the classroom (Seminar, Sept. 4). The particular structure of conferencing involving the planning, observation, and reflecting conferences was deemed necessary for sharing and pooling ideas to enhance collegial interaction. Teachers also decided that conferencing was important so that expectations and intents could be made clear, and their energy could be focused on the sharing of ideas and alternatives between and among themselves to create the environment for risk-taking and experimentation.

Therefore, the teachers' first experience of addressing the questions, "*How could we bring the group structure into the classroom? How are we going to do it even in the 35 minute class periods? How are we going to accommodate everything?*" was approached in a practical way, the way of experiencing. Teachers were asked to plan a lesson, similar to lessons they had written in the past, which would then be tailored to fit the new perception of a typical class on the MLP. This they did. Hence, with the *tools* for *Cognitive Coaching Discourses* that teachers had been exposed to, along with the constant reflection on each enacted activity, they forged ahead to translate each of these experiences into their own mathematics teaching and learning situation.

CASE I

MRS. SCOTT and HER CLASSES

Mrs. Scott's First Cognitive Coaching Experience

Venturing into the first attempt at translating the seminar experiences into the classroom, the teachers were hesitant. However, this was surmounted during the seminars on September 4 as Mrs. Scott's lesson plan was completed first. She planned a lesson on percentage which was teacher-directed. She led me through her lesson, and we discussed the student-related activities. Together we modified it to incorporate some of the salient *tools* decided on for the *mathematics learning experiences*. These included student groups of three with a role for each group member ("questioner," "recorder," and "teacher"). We then tailored the *tool* of conferencing to be incorporated into the student group activities. For example, with respect to "creating an image" to the planning map (Costa & Garmston, 1994, p. 18) to incorporate problem solving techniques we decided that ideally the "questioner" would ask questions such as (a) What is our objective? (b) What strategies are we going to use to solve this problem? (c) What will our answer look like? and (d) How can we verify that our solution is correct? I anticipated that similar questions would be used by teachers during their planning conferences and would be translated for the problem solving situation in the mathematics classrooms. The ultimate goal was for the students to begin to use the *tools* to explore their learning of mathematics.

The Planning Conference

Mrs. Sinclair volunteered to coach Mrs. Scott. Hence, the first coaching dyad was initiated. Using the conferencing map (Costa & Garmston, 1994, p. 18), we entered the first planning session with the usual laughter that attended all our sessions as Mrs. Scott rehearsed her revised lesson. While the teachers as learners engaged in this activity, they sought verification and directives from me to ascertain whether they were on the right track. This was the beginning of my emerging role as co-coach. They also sought clarity about the particular direction they needed to take. With the coaching dyad decided on, a Grade 9 class consisting of 40 students was made available for one class period of 35 minutes for this initial venture. (This class was not one of Mrs. Scott's assigned classes for the school term).

The planning conference provided a detailed mental rehearsal of the lesson. It involved re-attending the objectives planned for the lesson, the teaching techniques, and the strategies to be employed to achieve the desired objectives. Students' activities that would determine evidence of achievement were also taken into consideration along with the data that the coachee (the teacher) desired to be collected by the coach during the lesson observation.

The natural element of reflection which attended all activities was also done after the planning session. As Mrs. Sinclair, the coach, looked back on her coaching to examine it in light of the non-judgmental *tools* for *Cognitive Coaching Discourses,* she stated:

> *I am not sure I waited the wait time and silence. I did not think I got that one. Throughout the session, I was always asking myself "Should I wait?" . . . but I guess I just wanted to finish. This is the first time we are doing this; I wanted to rush it through . . . and with the eye contact and the body language . . . that part, I couldn't concentrate on those.* (Sept. 4)

While being conscious of the techniques inherent in *Cognitive Coaching Discourses*, Mrs. Sinclair noted that she had to, as it were, put aside concentrating on them and focus on the new venture—the elements of the planning session.

The Lesson Observation

After the planning session, the teaching-learning event took place. The topic under discussion was percentage. Mrs. Scott executed the planned lesson with minor changes. She used direct teaching in the introductory session, recapitulated with the students the development of the concepts of percent and the finding of a given percentage of a particular whole number quantity. Students were then grouped and assigned specific roles. Mrs. Scott offered suggestions for the execution of the three roles we had suggested. For example, the "recorder" could write down the solution process of the problem, while the "questioner" should ask the questions that we tailored from Costa and Garmston's planning map, and the "teacher" would respond to the questions and provide explanations.

Students were asked to utilize the concepts they revised and were given mathematical problems to solve in the group-setting. The examples Mrs. Scott used to find the percentage of a given whole number did not include any word problems. However, for the first students' activity she gave the word problem: *"John's mother gave him a school bag. On the following day his aunt gave him a similar bag. He decided to sell one of his bags for J$350.00. One of his friends offered to pay him J$385.00 for the bag. Another friend offered him 25% more on the J$350.00. Which is the best offer?"* Students executed their roles in each group and solved the problems.

That which was not planned emerged as an innovative closure for the lesson because of the way Mrs. Scott elicited the response to the solution of the particular mathematics problem. She asked the questioner from one group to coach the recorder from another group through the solution process of the problem. This they did as they orally took us along the solution path of the given problem. After students solved the problems, they were also asked to write their reflections on their experiences in the group activity. This was prompted by the question: *"What did you like or did not like about your group activity?"*

The Reflecting Conference

After the class session, we returned to the seminar room and reflected on what had transpired during the lesson. The data collected were presented and reflected on. It was observed that students solved the problems in their groups with everyone participating. They were constantly on task. All groups were able to solve the word problem. In most cases, however, the solution paths did not take that of the teacher's examples, but took a path unique to individuals within the groups. According to Mrs. Scott, "*Most of them went back to how they were used to solving it*" (Sept. 4).

The conveyance of judgmental messages through verbal and facial expressions did not escape the eyes and ears of the observers. In her introduction, Mrs. Scott had asked: "*Anybody like fractions?*" with the expression of dislike on her face. She also said she was asking "*some bright person*" to give their ideas of what percent means. The teachers' consciousness was then raised about the possible implications of these judgmental statements and expressions. These were explored in light of what they might mean for the students, and the conscious effort on the part of the teachers to be aware of their own verbal and non verbal judgmental expressions in the classroom setting.

As an integral part of the reflecting session, Mrs. Scott summarized her impressions and assessments of the lesson and provided data to support them. She observed that she was happy about the students' response to the grouping. They took under two minutes to settle down in their groups. Mrs. Scott stated:

> *The other thing I enjoyed about the class was their response to the grouping. They got in their groups quite quickly. There wasn't anyone who was going around trying to select a friend; they just got in their groups quickly.* (Sept. 4)

Mrs. Scott also noted that "*There was some confusion with the roles . . . if I had taken the time to explain the roles before initiating the whole discussion concerning the strategies to solve the problem,*" probably the confusion would not have occurred. This confusion, however, was healthy as it occurred naturally as in an everyday lived situation. Mrs. Scott observed that probably, because she did not explain in detail the role of each person, "*The 'teacher' in some groups was imitating me, asking the questions, solving and writing it*" [the solution].

The word problem Mrs. Scott gave to be solved posed some difficulty in interpretation for the students. However, the structure provided by the execution of the roles in the groups seemed to aid in the analysis of the problem so that the problem could have been interpreted and solved correctly within each group. Hence, Mrs. Scott reported that initially, "*Some students were not able to read and analyze the question . . . hence, the necessity of the whole grouping.*" However,

> *within the group they were able to reason and to analyze and to solve the problem. Whereas if they were on their own they would not have gotten rid of most of the cobwebs of interpreting. So interpretation . . . in that sense was taken care of.* (Sept. 4)

Mrs. Sinclair observed that the group setting lent itself to maximum participation of all students. "*I noticed,*" she reported, "*that all the students were participating in the group activity. It was not like this student was working by himself or herself; they were really at one. The three persons were working as one.*" From the level of interaction within the group, Mrs. Scott also postulated that, even if another mathematical problem were structured at a higher level of difficulty, the kind of thinking generated within the groups might also lead to the solution of the problem. Mrs. Scott stated:

> *The question, . . . I see wherein it could . . . require much more critical thinking. In that group setting, the fact that everybody was participating, I could have come to another question that was pitched at a higher level, and I think they would have solved it just by the whole participation; . . . so that anything they came across they could have solved.* (Sept. 4)

The teachers read the students' written reflections. Students were asked to write about their experiences in the group at the end of the lesson. As teachers examined students' responses, each concluded that the experience made a difference for the students. Bringing closure to the reflecting conference, Mrs. Scott stated that the only thing she would have done differently if she had that group again was to rotate the roles since the desired effect of maximum participation was achieved on the students' part. "*You noticed that all students were discussing?*" Mrs. Scott queried.

Reflecting on this reflective process, Mrs. Scott observed that Mrs. Sinclair had done well in not being judgmental throughout the process. Mrs. Sinclair, however, expressed the difficulty she had maintaining a non-judgmental stance. She stated: "*It was very difficult not to be judgmental because I am so used to the assessing . . . what the teacher did or did not do.*" Mr. Lennox, on the other hand, provided a general overview from his observation of the whole situation: "*I think we are being informed about the difference between evaluating and coaching; there is a difference there, the non-judgmental aspect.*"

Teachers' initiation to the *tool* of conferencing led to an investigation of how student group-structure could be brought into the classroom-setting; the plans made were effected and the immediate impact was observed and reflected on, a process which led to the deduction of the difference between the process of evaluation and the process of cognitive coaching (**Finding # 19**).

Students' Reaction to Their First Math Learning Experience on the MLP

The grouping of students encouraged their maximum participation. They assumed their roles in asking questions, giving explanations, making suggestions, and recording the solution process. This execution of their roles led to the solution of the problems within the groups. According to one student, *"As the recorder of my group, I see this exercise as being very beneficial, and the group work let me understand the problems better."* Another student who acted the role of teacher stated: *"As the teacher, it has inspired me to work with others and teach them what I understand. To see them understand is the best thing."* The questioners also did not restrict themselves only to questions suggested by the teacher but also generated their own as they saw fit.

Most students stated that they did not know they could understand the concepts by working in the group activity with their fellow students without the teacher telling them. The general reaction of the students with regard to the group activity was expressed by a student, *"It has shown me that I can work with my fellow peers and understand."* Another stated: *"It has helped me to challenge my brain and my reasoning."* They also stated that the privilege to work with their assigned roles gave them the opportunity to think on their own as a result of the mediation of their friends without the teacher's prompting. According to another student, *"It has given me an ability I didn't know that I have—to think on my own with the help of my friends without a teacher."* For all students, it was an opportunity to understand the problem better. One student was certain that *"If this little has helped me to stop fear math a little, if the class continues to be like this I know it would be good for me"* (Seminar, Sept. 4, 1997).

Students concluded that they were being shown how they could work successfully together and help each other to think; thus, they were challenging each other intellectually and were achieving a deeper understanding of the solutions to the problems. The roles also inspired students to work with each other and to experience the joy of seeing their peers understand particular concepts. It also provided an initiation to the removal of the fear for mathematics, as one student noted: if this single experience could initiate such a change then should such an experience continue, it would be of great benefit.

CASE I-- Part II

Mrs. Scott's Initial Experiences to Generate the MLE With Her Math Classes

The first week of school at Dominion High saw students and teachers adjusting to and getting acquainted with their classes. I did not visit the teachers' classes during the week of the 8th of September; I thought it was best for them to make this initiation to the new approach by themselves. Without my assistance, they started to translate their seminar experiences by introducing aspects of the MLP they thought best to incorporate in their teaching.

Mrs. Scott, having had the opportunity during the last day of the September PDP seminars to tailor and teach a lesson using the *tools* deemed as salient elements of the MLP, embarked on her translation of these experiences with her assigned classes. She decided she would introduce her 4-Arts Girls (Grade 10 Girls) to the *mathematics learning experiences* (MLE) since these students had been perceived and streamed as slow learners and were a part of the set that was not selected to be prepared for the external examination in mathematics, the CXC.

Visiting Dominion High on Monday September 15, I met informally with Mrs. Scott, who gave me an overview of what was happening in her class. She stated:

> *The first week of school we were just getting to know the students and trying to get settled. But when I saw the end result that within one week there was a marked change in their approach, to be very honest, I was very excited when I left that group today.* (Informal meeting, Sept. 15)

Mrs. Scott explained that she had gone to class that morning with the usual expectation of hearing the moans and groans when she asked about the few problems that were assigned as homework, only to be shocked by the students' responses. She explained:

> *Believe me Mrs. Mac, when I went into the class today and expecting the usual reaction "hard Miss" when I asked, "How was the homework?" It was not so at all. Because usually they were working on their own but now they worked in groups. Some said they worked up to 30 problems, and so I said "30? So you all copied?" but they said "No Miss" and they were able to explain on the board. Even when I asked questions that would cause them to think that I was inferring that they were wrong, they said: "No Miss" whatever . . . whatever . . . they knew exactly what they did. Believe me, I am so enthused and excited to know that my 4-Arts Girls did that!* (Sept. 15)

As a result of introducing group-work with assigned roles, students worked on far more problems than were assigned. Mrs. Scott felt they showed understanding of the concepts and interest in what they were doing. Consequently, she felt enthused and motivated. She explained that "*the 'teacher'* [meaning the teacher in the groups] *decides what they do, and they find their own time to meet and to work together on their homework*." She reported that, after the class session that day, she assigned the usual few problems. *"One young lady said, 'But Miss we don't have you again until Thursday, I don't have to stop at 50, I'll just continue.'"* Mrs. Scott explained: *"Now, you don't usually get this sort of response from the students. These are the weak ones who didn't want to do math at all."* Mrs. Scott explained that even "*when the boys came over from their class, one young man said 'Miss, how come you pushing them so fast?' I said 'I am not pushing them; they are just zooming.' I sort of wish they would calm down*" (laughs) (Sept. 15).

Even the girls' classmates, from whom they were separated, recognized the change in these girls in such a short time. Mrs. Scott confessed: *"Honestly, I thought the coaching thing would slow down the process, honestly*" (First Reaction, Sept. 15). However,

> *when I compare what they are doing now with the brighter stream that they have been separated from, I marvel, I really marvel. I had to just step out of the class today and I went walking along the corridor to see what the other classes were doing; I just had to stand up and say these girls are something else* (Sept. 15).

Mrs. Scott explained: *"My objective for this first week was to see if the students would really work in their groups. Since it is the first time, . . . I wanted to see if it would really work."* She further explained that *"What I am working on is for this class to feel comfortable within the groups, and most importantly, for them to see that when they work together each person benefits."* To be certain I was interpreting her correctly, I queried, "*So you are working on interdependence?"* She agreed. However, this experience for the students did not take place without some measure of difficulty. Mrs. Scott went on to explain some of the difficulties she experienced in the classroom:

> *Initially, some did not want to work with this one or that one; so today when I said, "Change groups, not the same set of three," they quickly rearranged the groups. They are seeing the end result of the grouping even for this very short period. Now they realized that on their own they would have been meeting just dead ends. So I think it is coming together for that class. The grouping is really helping them.* (Sept. 15)

The initial difficulty experienced as students selected their group members paid off in a short time as they also had to work with other members of the class through random grouping. At the beginning of the school term, Mrs. Scott informed the students that they were free to choose not to participate in the group activities which would be offered. One student chose not to participate in the initial stages. Mrs. Scott stated:

> *When the young lady wanted to work by herself I did not trouble her at all. I saw what was happening to her, but I did not do anything. This week, today, everything changed. I think sometimes we are too quick to correct, . . . but just by leaving her alone she found out the benefit of the group for herself. When she saw how the others were getting on, . . . within a week she was behind the others because of the grouping that was taking place. So this jolts her into reality that she was really behind, and those who were working in the groups were now more advanced than she was on the particular thing they were working on.* (Sept. 15)

Because students were given the choice to participate in the activities offered, they were able to decide for themselves whether doing so was worthwhile. One student chose not to participate initially, but soon realized that grouping was making a difference for the others, especially those she considered less academic than herself.

Mrs. Scott also reflected on her new role in the classroom. She explained that her role was changing as students were being empowered to take charge of their learning. She explained:

> *I am more the coach now because they have their own teacher in the groups. So I just go around and say "Do you have any problems?" or I'll just sit and mark their work. I might identify some errors, . . . and I would say "Look here this is happening to the group," so I would ask "Who questioned this?" And I would encourage them to question things and not just to accept them, and so they would begin to question each other "Why?". . . I feel so enthused. I really feel good. When I walk around and visit the groups and I hear the arguing, the no's, and the questions, I really feel enthused and excited.* (Sept. 15)

At this point, I asked: "*Would you have me in your class*?" She replied: "*Sure! No problem*." Knowing that the accommodation of these techniques takes time, I started visiting Mrs. Scott's class on Thursday, September 18, observing, making suggestions, and becoming a part of her class. My visits, Mrs. Scott later averred, did not intimidate her in any way but prepared her for the unexpected visit of the principal to her class.

Even though we had seen how Mrs. Scott introduced grouping to her experimental class during the September 4 seminar, I was curious to know how she introduced it to her 4-Arts Girls. She explained that the formation of groups was similar to those done during the seminars. Students formed groups according to how they were seated in the classroom—grouping with those close by or across the aisle. She also explained that the assignment of roles took a different turn from the way she did it during the September seminars. She introduced the roles to her 4-Arts Girls one at a time. Each group member was assigned a role, but she took the time to have each person within the group role-play just one role for an activity. For example, the role of the "teacher" was introduced and executed first during a class session—a double period. After all the students took their turns as the teachers within the groups and felt comfortable with the particular role, Mrs. Scott introduced them to the other roles (Notes, September 26, 1997).

Mrs. Scott's Sharing of her Classroom Experiences at the First Monthly PD Session

On September 22, Mrs. Scott and the other three teachers at Dominion High met with me to provide a verbal response to the questions given on September 4 eliciting their reaction to the experiences of both sets of the *professional development* seminars. Teachers were given a set of questions and were asked to write their reactions to their seminar experiences at the end of the September seminars. However, they had not done so. This meeting, therefore, served a dual purpose by providing the responses and by having teachers share with one another the aspects of the MLE they were focusing on in their classes.

During this first monthly PD meeting, Mrs. Scott informed me that *"In just about all the classes we are doing aspects of it . . . but I am really trying to get it going in that one class, . . . the 4 –Arts Girls.*" From what the teachers shared, only Mrs. Scott had translated much of her PDP experiences into her classroom teaching. She stated that she was experimenting with this particular class and showed that grouping was working with those in upper-school who were used to the competitive and individualistic learning situation: "*I am experimenting. The group that I do most of the grouping with almost every class is that set of 4th Form* [Grade 10] *girls, and they are moving faster*." Mrs. Scott also acknowledged to the group her initial fears: *"Initially, I thought it would be slower . . . that this whole group thing would waste our time. That was really what was at the back of my mind,"* but she reassured the group of teachers that the students *"are moving faster."* Mrs. Scott went on to explain her new role:

> *I am not lecturing so much, but it is more of coaching them in the direction they need to go and I find that they are going faster. I am not lecturing and they are learning more; they are discovering more, and they practicing more. I think that comes as a result of the fact that they are enthused and they believe that they can do it as a group. Whereas before, if they were not sure, they really didn't want to try.*" (PD, Sept. 22)

From her students' response, Mrs. Scott concluded that the grouping seemed to be influencing her students to experience a greater sense of efficacy; this resulted in their venturing into areas they would not have normally ventured into. Thus, she felt they were gaining a deeper understanding, discovering more, and practicing more problems as a result of the enthusiasm they were experiencing in the group-setting.

With the reciprocity inherent in coaching, the structural changes that occurred due to her own translation was consistent with the nature of the approach: *"Even though I might not be going about the whole coaching thing like how we did it,"* Mrs. Scott felt she was tailoring it for her situation and was applying it in her own way bringing out the ripple effect or the circularity inherent in the approach. She continued:

> *You coach the group; they ask you a question; you ask them a question in return. I think I have taken the essence of it and have been trying to apply it. I think as you go on and you have mastered certain areas you add to it. Right now, I think I am at the beginning of the coaching; I would not say I have perfected the art.* (Sept. 22)

Mrs. Scott explained that she could not boast of mastery of coaching at this stage but was translating salient aspects of her experiences from the PDP seminars. This experience was new to her: *"Prior to these seminars, I was zero concerning coaching; . . . the whole deliberate approach, no, I must say that was not my approach at all, not my style."* However, Mrs. Scott was embracing the principles and was helping her students accommodate these in their *mathematics learning experiences.*

From Mrs. Scott's perspective, the approach was neither wasting her time nor the students' time; in fact, students appeared to be learning at a faster rate as the executed roles in groups were empowering students to function as a unit and solve problems for themselves without depending on the teacher. Thus, they seemed to be learning by understanding through discovery and practice.

Generating MLE with her 4—Arts Girls, Mrs. Scott experimented with the *tool* of grouping with assigned roles; students exhibited a marked change in their attitude/approach to mathematics and were learning more, discovering more, practicing more, and understanding more at a faster rate (**Finding # 20**). Mrs. Scott's role was changing from a lecturer to that of a coach, she was also making her own application of the coaching techniques for the students' *mathematics learning experiences;* hence, the *Coaching Approach* seemed reciprocal and circular. As the teacher questioned students in their groups, the students in return questioned the teacher and questioned one another within their groups (**Finding # 21**).

Mrs. Scott's Being Empowered and Developing Autonomy

Learning what had been taking place in Mrs. Scott's classes and having been invited to visit them, I tried to find out what would be happening in the class, how she intended to do what she planned, and the reason for the intended action before each visit. The mediational aspects of coaching helped to bring forth, from her repertoire, alternative ways for approaching a particular activity; failing that, she solicited suggestions from me. As a result, my role as supporting coach emerged.

It was also difficult to have planning time before classes as most of Mrs. Scott's free moments were spent in meetings due to her role as Department Head. Therefore, in the initial stage, our planning took place in the corridor on the way to class. Hence, my planning sessions with Mrs. Scott were minimal. We never sat down and went through a formal planning session for each class. However, Mrs. Scott always did detailed lesson planning. As a result of her first experience with the planning conference during the September seminars and using the "planning map," she began to automate this way of thinking as she prepared for her classes. She asked herself what her objectives were; how she was going to accomplish them; and how students would show that her objectives were achieved. She also generated possible alternatives for each activity.

After my first observation and my becoming a part of Mrs. Scott's classes, with the thought of the sustainability of the MLP from this beginning stage, I tried to give her as much autonomy as possible. One way I thought of doing this was to video tape some of her lessons so she could be her own observer instead of depending on me as coach. After watching herself on the video, Mrs. Scott was able to pinpoint some of her weaknesses and decide what she would improve for subsequent classes. Our reflecting sessions, however, took place almost always after school, were always detailed, and involved the examination of the theoretical implication of each issue under examination. The reflecting sessions also served to inform her planning sessions as we thought of aspects that should be focused on during her preparation for the next class.

Exploring the Path of the Mathematics Learning Experiences (MLE)

In addition to introducing her class to their small group roles, Mrs. Scott also concentrated on developing a climate so that the MLE might be embraced to its maximum. Mrs. Scott's role was now changing from a lecturer to a coach, thus allowing her students to develop their mathematical abilities.

Embarking on the MLE in the initial stages, Mrs. Scott started her classes with a short session of direct teaching; then groups were assigned a set of mathematical problems to be solved. Students in their groups were asked to solve the problems executing the roles they were assigned. For each class session, Mrs. Scott ensured that students were active in their roles. She would also encourage role rotation. She would tell students: *"Change roles today; the person who was teacher last time should now be the questioner or the recorder."*

By Monday, September 29, Mrs. Scott was at the stage in the *mathematics learning experiences* at which her class was ready for *Mediated Discovery* – (a term which I have coined), where teacher or students would utilize the *tools* for *Cognitive Coaching Discourses* to give clues while not defining or directing what they wanted the persons solving the problems to derive. Without any form of direct teaching, Mrs. Scott had her students attempt to solve a set of problems in their groups without her intervention. The quadratic expression $x^2 + x + 3x + 3$ was given to the students, and they were asked to factorize it. The premise was that students' mathematical experiences and mathematical histories would allow them to draw on their repertoire of knowledge to arrive at a solution for this and similar problems. Since the climate had been set for this kind of work, students never complained or fussed. They got together in their groups, executed their roles, and drew on their knowledge and experiences.

One of the first things students did in their groups was to group like-terms and take out the common factors, which resulted in $x(x + 1) + 3(x + 1)$. Most groups were stuck at this step and could not go any further. Some groups through trial and error first took out the bracketed factors $(x + 1)(x + 1)$ as the factors, but when they multiplied them they did not get back the original statement. Students, by this time, had been verifying their solutions as a natural part of the solution process to ensure that their solution was reasonable.

Two groups I worked with were reminded through questioning of their original objective. That is, they were to come up with two factors, and so the two sets of brackets as symbols were provided ( ) ( ) as a reminder of what their answer should look like. Then they grouped the expressions with common factors $(x^2 + x)$ $(+3x + 3)$ and factored out the x and came up with $x(x + 1)$ and for the next term +3 was common, so it was factored out, $+3(x + 1)$. Since students were working towards two factors for their answer and since, they had two factors in the brackets, they multiplied them, i.e. $(x + 1)$ $(x +1)$. This did not give them the original statement, so again this group was stuck. Again, they were redirected to look at the previous step and to examine it to see if they noted anything different about the two factors they came up with. Then they started to focus on the "x" and the "+ 3" which were outside the brackets. Then one young lady put them together $(x + 3)$, and used one of the two $(x + 1)$ to multiply the $(x + 3)$. Then they realized that they got back the original quadratic statement. They decided that those were the factors. However, students could not explain why or how the "x" and "+ 3" came together. They said they were putting the pieces together. After coming up with the correct answer without knowing why, they shared this in the large group-setting and the class teacher provided the missing information.

While sharing in the large group setting, another group stated that they added the two middle terms and got 4x, and readily saw that it was the difference of two squares, so they were able to come up with the factors $(x + 1)$ $(x + 3)$. All groups had the opportunity to share in the whole-class session the solutions that they came up with during each class period; this was an integral aspect of the MLE.

At their next class session on Thursday, October 2, students went on to an added dimension in the solution of quadratic expressions. They were assigned a set of problems from the text book and was told to solve them. The set of problems included $x^2 - 36$; $x^2 - 100$; $x^2 - 169$; and $x^2 - y^2 + 5y - 5x$. As had become the norm for this class, each student empowered each other in their roles. In one group, to begin the problem solving process a member of the group said: *"Come, explain now teacher."* The group-teacher explained the first three which were just exercise items for them but this last one was a problem. One student's remark was: *"This one looks dread!"* This time, one factor in the solution set had three terms (x - y)(x + y - 5), and they were to come up with the two factors. They were not told anything by the class teacher, and I was videotaping, so I did not participate initially in any of the group interactions. Mrs. Scott had been going around to the various groups to observe what was taking place within the groups and to question the students concerning what they had done and to mediate the next step.

In their groups, students offered suggestions about how it ought to be solved and explored the suggestions together. In one group, as they worked, one student remarked: *"No, something is wrong!"* They identified that something was wrong with their solution but could not say exactly what it was. The teacher in the group suggested that they should work it individually. This, they did but were not satisfied with their solutions. They recognized that they had a problem with multiplying negative and positive signs. One student's remark was: *"I can't go any further; I am stuck. We have reached so far and don't know what to do."* Mrs. Scott came by this particular group so they invited her to examine what they had done: *"Miss, we can't get this one. Look at what we have done and we still can't get it."* The Mrs. Scott reviewed some of their attempts with them, as it were re-living the solution process and helping them to see what they did and to identify their mistake.

She questioned them concerning what they had done. The students explained as they were questioned. Then she said: *"So factor that out and tell me what you have left. . . . See, you have the solution there sitting on a long time."* The teacher left them to continue the solution process. They still did not know exactly what to do. So they re-examined the solution process they just explained to the teacher, identified what they had pointed out to her, recalled her questions, and asked themselves the same questions.

Returning to the point where their mistake was made in the solution process, they recalled her suggestion to factor the expression.

Group-teacher: *What did she say to you?*
Student 2: *She said the answer is infront of us* (laugh).
Group-teacher: *She said you should cancel it out. She asked: "What is common to both of them?" So what is common to both of them?*
Students: (chorus) $x + y$

Group-teacher: *So we take out the x + y and put it over there. What do we have outside now?*
Students: (chorus) - *5!*
Group-teacher: *So we are going to have -5 and bracket it.*
Student 3: *But where would we get . . .? oh . . .*
Group-teacher: *And so over here we add back the -y. Oh Yes! (laugh)! Let us work it out now on a plain sheet! Wow! You know how long we have the answer?*

As they came up with the solution to the problem Mrs. Scott interrupted the small group discussions so that the students could come together to share what they had come up with in the large group setting: *"Sorry to take you away from your group time"* she remarked, and invited group members to write what they came up with on the chalkboard and to offer their explanations (Small group MLE activity, Oct. 2).

Embedded in the given problems, students were to recognize that $x^2 - y^2$ is the difference of two squares, and they should factor it $(x + y)(x - y)$ and add this to the other terms $[(x + y)(x - y) - 5x + 5y]$ to deduce the factors $(x - y)(x + y - 5)$. Three groups came up with a form of solution that they shared in the large group-setting by writing it on the chalkboard and explaining it to the class. However, for two groups, the sign in one of the factors was incorrect. One of the three groups came up with something different. The other two groups were unable to come up with anything at all.

Prior to the sharing in the large group setting I recognized that one of these two groups had exhausted their previous knowledge in reaching the stage of the solution they were at; I intervened to lead them beyond this zone. Based on what they had done, I questioned them to find out how they had arrived at that stage and continued to pace and lead them to the next step that they ought to take. As students shared in their large group-setting, together they were able to derive the solution as the errors became obvious as they verbalized the procedures they came up with.

During our reflecting session on October 7, Mrs. Scott and I examined the approach we had been embracing in her classes—the *Mediated Discovery Approach*—to bring about conceptual learning. *Mediated Discovery* involved situations in which the opportunity was given to the learners to explore and exhaust the "coupling" of their thought processes towards the solution of problems in the group-setting. In this setting, the learners are provided with certain *tools* or symbols to act as a mediator towards the full solution of the particular problem without being told how to do it by the teacher. For concepts we perceived that could not be developed using this mode of teaching, I suggested an alternate way.

The *Mediated Discovery Approach* is the process by which learners in small groups with assigned roles employed mediatory *tools* to draw from and to pool their experiences so as to explore or exhaust the "couplings" of their thoughts and ideas to solve problems on their own **(Finding # 22)**.

An Alternative to Mediated Discovery

The alternate approach, suggested during the reflecting session on October 7, builds on to was done initially using *Mediated Discovery* in which the problem-solving techniques would be employed by the questioner and explanations would be offered by the responder. By incorporating direct teaching, which was done by the class teacher, each student within the groups would now become a teacher. Each would re-teach the solution process shared by the class teacher. Each student would do so, by taking turns within the group. Students would use the same problem or the same type of problems dealing with the same concepts. The questioning technique, as in *Mediated Discovery*, would be incorporated throughout the presentation by each student within the groups when gaps in explanations or when misconceptions were identified by the other group members to whom presentation was being made. Because of the reciprocal nature of the questioning and the explaining by the questioner(s) and the responder, I termed this—*Reciprocal Mathematics Teaching* (RMT)—The term emerged from my re-conceptualization of reciprocal teaching (Brown & Palincsar, 1984).

I explained to Mrs. Scott that I envisioned that the gaps in understanding and the misconceptions would be recognized by the presenter as well as those to whom the presentation was being made as each took turns in explaining the solution process. As students verbalized in their own "language" what they understood, it would be made clear to the "group-teacher" what he or she really understood or did not understand. As this was being done, clarification would be sought for the misconceptions and gaps that were recognized. This, I assured her, might result in *Personalized Learning.*

Personalized Learning, I explained, is the experience during which whatever has been shared and embraced by individual learners will be verbalized or acted out by them as they use their means of expression to communicate to others what they understood about the particular concept or phenomenon. This leads to conceptual learning and the "*key to conceptual mathematical learning is mediation and reflection;*" I reinforced (Notes Oct. 7).

Reflecting on what transpired in her class with the 4-Arts Girls on October 2, Mrs. Scott decided that, after the mid-term break, she would introduce grouping to her 4-Science mathematics class as she wanted to compare the effects of the MLE on both groups. She had already been noting differences between her 4—Arts Girls on the MLP and the science group which was not on the MLP. Already she had begun to introduce and utilize the non-verbal and verbal non-judgmental strategies with her 4-Science mathematics class (Notes, Oct. 7). She also noted that she wanted the grouping as an integral part of her class sessions and had already started to write it as one of her objectives in planning lessons for her other classes (Oct. 7).

Mrs. Scott also shared with me her plans to organize the October professional development session using the format I had shared with them previously. This meant that the monthly professional development meetings had now become that of the administration of the Dominion High. I was very happy to hear this. To me, this meant sustainability! Plus, the task of planning was not on my hands (Notes, Oct. 7).

Creating a Trusting Atmosphere for the Alternative Approach in Mrs. Scott's Class

Along with this different approach to teaching and learning was the addition of the element of caring and the development of the culture for caring in the mathematics teaching and learning context. At the September PD meeting, Mrs. Scott related one of her experiences regarding the holistic nature of the MLP: "*As it relates to the holistic aspect, an example, like today,*" she explained:

> *I went to the class and I started teaching; I noticed that one young lady . . .* [was not attending] *I was not sure what was happening to her; then I noticed tears. Then someone said: "What are you crying for?" . . . Then she related to us that someone had stolen her mathematics text book. So I told her: "You don't have to*

> *cry about that just share it with us and we can all chip in; remember we are a team." And everybody said "Yes, we are a team."* (PD, Sept. 22)

Mrs. Scott told us that most Grade 10 mathematics groups were time-tabled for mathematics at the same time and were using the particular text book. So she continued with her lesson because she, along with her class, assumed that *"It must be someone who had mathematics at that time who stole the book, . . . so we allowed the classes to settle."* At a point during the lesson, they decided: *"Now it was time for the team to take action, and we divided the class into groups so that everyone could take an aisle in the different classes."* Mrs. Scott explained: *"We quickly searched the classes and we found the book and when we came back they were all 'rah, rah, we are a team!'"*

She went on to explain that normally, "*I would say: 'girl, stop yu crying in a mi class, and go look for yu book,'* (Girl, stop your crying in my class and go and look for your book) . . . *because you think she is a big girl, why sit there and cry when she can go and look for the book. Someone must have the book.*" But, "*Because of the atmosphere that we have developed, we automatically just moved in on this thing – let us all go.*" Mrs. Scott explained: *"The teachers allowed us to come into their classes and we quickly searched the classes and found the book! . . . We did not lose much time . . . neither did it take much of the teachers' class time to find the book."*

Teachers were forging new practices, yet not in isolation. This, Mrs. Scott agreed, was part of "*the whole aspect of the holistic approach.*" *"And the team-work too,"* Mrs. Sinclair added, and then explained: *"We realized that there was a problem in Mrs. Scott's class so we allowed the students to come in."* Mrs. Scott continued: *Mr. Lennox and Mrs. Sinclair . . . quickly gave us the break, and as for the culprit we left him to the individual teacher to deal with, and we moved back to our class quickly* (Sept. 22). While Mrs. Scott and her class were working together as a team, they were not doing so in isolation, but the team-work transcended the borders of her classroom to include the community of mathematics teachers and their classes. They were beginning to work as one big group, one team—a network. Mrs. Scott concluded: "*I think that Mrs. Sinclair said it, but I'll just say it again; that is, that it is that trusting atmosphere that is being created, I think that it is making a difference*"(PD, Sept. 22).

Caring and team work in one class transcended the borders of the isolated classrooms to include the community of mathematics teachers and their classes, thus aiding in the generation of a trusting culture for mathematics learning.

Mrs. Scott's Suspending Her Certainties to Give Her Students A Voice

One key feature that emerged for the *mathematics learning experiences* (MLE), as a result of the PDP experiences was that, initially students would work on problems in their groups with the assigned roles; then, after coming up with a method(s) of solution, each group would share the solution(s) in the large class-setting. During my first visit to Mrs. Scott's class on September 18, students in their groups were assigned a set of quadratic expressions to be factored, for example $x^2 + 5x + 6$. However, the new concept Mrs. Scott wanted to teach this particular class was expanding (multiplying) two binomials. After working in their groups, a member of each group shared the procedure used for arriving at the factors of the given quadratic expression by recording it on the chalk board and explaining it. With the solutions written on the chalkboard, for example $(x + 3)(x + 2)$ Mrs. Scott directed the students' attention to the set of solutions for the given mathematical sentences, then asked what they observed.

The students contemplated their task, after which, one group offered their observations. Proceeding from the factors, they solved the problem backwards. The students deduced that the general expanded form for the set of factors (the binomials) was of the form: $a^2 + 2ab + b^2$ (notes, Sept. 18). Choosing one solution set as the factors, they gave Mrs. Scott the terms for the expanded form. However, Mrs. Scott was not anticipating the order in which it was given. First, they gave the first term: "x^2" and then the last term: "+ 4." Mrs. Scott, relating this experience during the September 22, PD meeting, explained how she had to suspend her certainties:

> *But it is my whole mental thing now; I was going in this order, but they were giving me the extreme ends first of all. . . . I really thought it was the middle term and it would not have been correct but she* [referring to me] *gently said "Just write it down," . . . pointing to the end; I wrote it down and realized that it was the end term they were giving me. . . . I did hesitate, which probably could have caused a sort of hesitance in them to give me another answer.* (Sept. 22)

Mrs. Scott related how communication during the verbal and non-verbal interactions, on the teacher level, aided her interpretation of what the students were trying to communicate. By responding to my prompts, she did not thwart the students' thoughts that were not stated in the expected sequential form. However, she recognized that her growth in flexibility helped her accommodate the verbalized non-sequential thinking of the students that generated that which was not given but deduced.

After giving the terms at both extremities, the students gave the middle term as "2x + 2x." Again, Mrs. Scott hesitated. Then with a sudden realization, she stated: *"Oh you are giving it in the expanded form*" [it meaning the middle term] (notes, Sept. 18). Perceiving her rigidity, Mrs. Scott realized she was expecting students to be thinking as she was thinking. She explained: *"Because you don't see it that way, and it just did not dawn on you that that is what they are really saying, how you handle that situation is very important* " (Sept. 22). Having given the particular response ($x^2 + 2x + 2x + 4$) as the expanded form for the set of factors $(x + 2)(x + 2)$, the group of students with much elation exclaimed, *"A we dat!"* (We did that!) (Notes, Sept. 18). They felt that their thoughts were not aborted prematurely even though they did not match the teacher's way of thinking. Consequently, when given the opportunity to voice their thoughts as they occurred, the true meaning of what they were thinking emerged.

Creating a trusting atmosphere for the alternate approach in her class, Mrs. Scott embraced teamwork that transcended the borders of the isolated classrooms; she gave students opportunity to voice their thoughts as they occurred so the meaning they intended could emerge (**Finding # 23**).

Towards the end of the class period on September 18, Mrs. Scott gave the students their first opportunity to reflect on the grouping experiences they had been introduced to since the beginning of classes during the second week of September.

The 4-Arts Girls' Reaction to Their Initiation to Grouping

The multiplicity of ways grouping affected each student's success in the learning of mathematics was expressed when students were asked to write a reflection about their experiences within the groups. One student, 1A, who was out of school for over two years but who was placed with this stream because of her age, stated:

> *The group affected my success in a very positive way. In the first place, I was lost in the math-world, but thanks to the guys for their effort and understanding of me of all pupils, and not only them, but thanks to Mrs. Scott. I like everything about my group; most of all we have the team-spirit.* (Written reflection, Sept. 18)

Feeling lost in the math-world, the team-spirit in the group-setting affected this student "*in a very positive way,*" she stated (1A). Student 15A also reinforced this by stating that

> *The group led to my success by the first principle of co-operation. Being co-operative in a group is very important because it helps me to express myself in that whatever I did not understand and the persons were there listening to me and trying to help me get the concept of what I did not understand. . . . The group had a very great impact on getting me to understand. The members of my group have also given me the courage to move on and to strive for excellence in mathematics. I liked the way my group behaved; they are very attentive and co-operative in all aspects.*

Most students mentioned that co-operation among and between members led to their success as each was given a voice in expressing what he or she understood or did not understand: "*The co-operation was very good because the questions were asked among us, and the teacher of the group would explain the concepts to the group*" (11A). As a result of the attention given, each was helped to move on as each strove for excellence. Even "*If a member of the group got the signs mixed-up or was having any difficulty with the problem, that person always felt free to ask a member to explain*" (16A). Therefore, "*no one is afraid to express herself in talking about any problem in the math, we all have weaknesses, and by relating our weakness in any area of mathematics we worked together and overcame it*" (17A). Student 8A affirmed: "*I didn't have to struggle by myself on a particular problem because I could discuss it with the members of my group*" (8A). The discourse in the group-setting provided the opportunity for "*me to give my opinion and to grasp the principles more,*" Student 10A acknowledged.

As a result of the group activities, Student 17A stated: "*My group also gave me a sense of courage in myself and is helping me to develop a likeness for mathematics*" (17A). The execution of the roles in the groups has also

> *helped me to see where I went wrong in working a particular problem, and has helped to develop my skills better, and has also helped me to know my peers*

> *better. Most of all, it has helped to build my self-confidence as I showed my group members things I didn't even think I knew.* (8A)

Another student, 3A, stated that she liked the physical setting of the grouping: *"What I liked the most about my group is the way it is set up."* She provided further elaborations about exactly what each student did as each played her role. She also stated that *"My group makes mathematics interesting, understanding, and fun to work."* Another student, 12A, elaborated on the effect of the grouping that was also voiced by all:

> *The group affected my success in understanding the concepts involved in the lessons. Well, this is mathematics! and I'm a little slow in this subject, but the group-work helped me, because not understanding a problem, I am able to ask a person in my group to help me. The advantage in my group was when a slower person keeps stopping to ask a question . . . it was a nice thing to stop and help her to understand what the problem is asking for.* (12A)

According to Student 19A, *"Working in my group you would not just understand math but master the subject in every way,"* because, *"before attempting to solve a problem, we discussed the problem and then attempted it and if I did not understand, the teacher of the group would explain it to me"* (20A). *"There was a lot of questions asked"* (6A), and *"if you didn't understand something you could ask the person explaining the problem"* (21A). *"I liked the way we discussed the math problems and how we attempted them using everybody's views and understanding"* (19A). Hence, *"The group worked together in solving a problem and when we worked together we were willing to take everyone's opinion"* (2A). Consequently,

> *Working in this group, I learn to work together and to give my own opinion. I also learn that working in the group really helps because if one person in the group does not understand, someone in the group can explain.* (2A)

Students suggested that the level of co-operation within the student-groups generated a sense of team-spirit, allowing everyone the freedom to express herself while other group members were very attentive and willing to listen. If students experienced any difficulty, they said they felt free to solicit help as each group-teacher was always available to help. They explained that, in helping others, they also helped themselves. The concepts became clearer while they were being explained. Each group member was also willing to give and take correction. As group members pointed out mistakes and explained how to overcome them, they worked together collaboratively trying to overcome weaknesses as they no longer had to struggle to solve a problem alone. Students stated that, by helping each other, they experienced a good feeling and greater self-confidence as they gained the courage to strive for excellence. Employing problem-solving techniques within the group-setting, students gained understanding and some also found mathematics to be interesting and fun.

Mrs. Scott's Experimentation With Grouping

As the days went by, Mrs. Scott never took anything for granted with her 4-Arts Girls. She wanted to explore other "waters" and to experience first-hand what would work and what would not. One of the first components of the *mathematics learning experiences* (MLE) that she wanted to test after it was established with this group was to find out whether the MLE would function as effectively with groups greater than three. Consequently, by exposing students to random grouping and different group sizes, she gave them the opportunity to decide the best group-setting they were able to work with. So with the decision to form groups of three during the seminars and their use for the initial initiation of this class to grouping, students were asked to change their group members during each mathematics lesson. Mrs. Scott also decided to change the group size to larger groups of five and six after they were exposed to groups of three.

After her experimentation, Mrs. Scott reported that, from her observation, students working in group sizes of five and six were not learning as they had been in their small groups; as well, the level of caring had decreased:

> *I don't think they are learning anything. . . . I still find that within the large groups I still don't get maximum participation. Some are still not saying anything. . . I think if . . . they were in their small groups they would have accomplished more. . . . There is not that caring among them in the large groups.* (Reflecting, Sept 30)

After establishing their roles in the groups of three during the initial stages, students ensured that each member participated in their particular roles for each activity.

Therefore, it was expected that the same working relationship would have been carried over to the larger group setting. Mrs. Scott observed that students working in the small groups of three were actively participating and learning, asking questions, and offering explanations. But, when placed in the larger group-setting, *"They were not ticking at all; they were saying they can't do it; they were complaining. Yet when they were in their small groups, you hear the 'oh!' 'I see,' because they worked together.*" The level of student participation was minimal when they were placed in larger groups and, according to Mrs. Scott, "*those participating tended to dominate*" (Reflect. Sept. 30).

In the larger group-setting, students were not giving a voice to each other; some were trying to "prove themselves" to their peers. This caused some to withdraw. Mrs. Scott related a particular situation in which one young lady was explaining but did not give opportunities to others who wanted to question certain things. She noted: *"Even when she was there explaining she wanted to shut up the other girl who wanted to think for herself.*" One particular student wanted to ask a question but, despite many attempts, was not given the opportunity. The one explaining did not want to be interrupted while giving her explanation, but kept on talking for a long time. This kind of behavior, Mrs. Scott deduced, caused a level of frustration, and so *"The frustration caused them to resign.*" This was happening because "*some of them . . . were not getting anywhere with whatever they were doing; it is like they resigned themselves from participating and from doing anything*" (Sept. 30).

With all the experimentation going on, especially with the introduction of the larger group sizes, Mrs. Scott observed that some students did not show that they understood the concepts dealt with when they were placed in the large group-setting. From this observation, she decided to "re-teach" some concepts using direct teaching. Mrs. Scott recalled: "*I was taking time out to ensure that they had the concepts . . . but you noticed in that follow-up class . . . they came up saying, 'Miss we are bored now with that; we want to move on.'*" Mrs. Scott explained that, within the original groups of their choice, "*They did it over.*" When they came to class they already understood and were ready to move on to other concepts.

Mrs. Scott expressed concern for students absent from the class when the original groups of three were formed and a student who transferred and who was not familiar with any other student in the class. Mrs. Scott stated that she would continue to work with these students until they found a group to work comfortably with. She decided that she would continue to move these students around in a random group format until they reached the stage at which they could decide who they felt most comfortable to work with (This was the purpose of random grouping).

Mrs. Scott decided: "*I am going to go back to where they go back into their small groups, and I am going to do that for every class . . . after I get their responses to the grouping.*" At this point, I reminded her that *"this is where the critical friend comes in, when you choose whom you want to work with*"(Sept. 30). The importance of the formation of groups with friends of one's own choice not only on the teacher-level but also on the student-level was crucial to the formation of collaborative relationships.

Because students started in this new group-setting on a different aspect of the topic they were dealing with, Mrs. Scott did not encourage a return to the smaller group-setting until students completed the set of concepts they were dealing with. By October 6, it was very obvious that students in this larger group-setting were not happy with their groups. They were looking rather frustrated. So Mrs. Scott, thinking they had become tired of the grouping, reverted to the old way of dispensing information. As well, she had all the students lined up at her desk while she was marking their books. This was a sad sight for me.

On October 7, during our reflecting session, I suggested that she should try to find out what the problem was by soliciting the students' responses instead of drawing an independent conclusion. I also suggested that Mrs. Scott introduce the word "craftsmanship" to students, reminding them how they started in their groups of three in which they each had a role and helped each other. In their small groups, they could ask any question they wished to clarify their thinking so that they could understand—they were perfecting their craftsmanship. Also, I suggested that she should remind them that in previous years they had worked on their own and as such they did not fulfill their individual potential. But now they were to choose the group they felt most comfortable with, the group in which they could ask any question, in which they could make any suggestion, and in which each had a voice (Notes, Oct. 7). To this Mrs. Scott agreed.

Students' Reflections on Working With Groups of Their Choice

On October 9, Mrs. Scott had her 4-Arts Girls return to the original group of three members with the students choosing their group members. Everyone was feeling efficacious except one student who was told by her group members that she needed to learn her times-table. She did not seem to take this kindly. Mrs. Scott acted upon my suggestion to solicit the students' opinion of their experiences with the different group-sizes at the end of the lesson. They were asked to reflect on the groups they had worked with and voice their preferences by stating which group-setting they preferred and why. Did they prefer working individually, in groups of three, or in the larger group-setting? Their responses were elicited through writing.

Of the 18 students present in class on October 9, 12 students stated that they preferred to work in groups of three; and three stated that, while they preferred to work with groups, it did not matter whether the group size was 2 or 3. One student said she preferred to work with the group of four—this was her original group size. Another stated that, while she liked to work in groups, she liked to work by herself sometimes. Eleven students stated that they preferred to work with the groups they chose, while two stated that it did not matter with whom they worked. The other five stated that they preferred to work in a group but did not specify whether by their choice or by assignment. Most students stated that they preferred to work in groups which were formed by their own choice.

Student 2A stated that what she liked best about reverting to the original group of her choice was that *"someone was always there to explain to you."* According to Student 8A,

> *I think that I work better with a particular group, because we discuss and disagree most of the time, and when we found out our mistakes, we can laugh about it together. We don't think anyone is better than anyone; we just worked together.*

This view was also reinforced by Student 9A, who stated, *"I like to work in the group that I choose to be in because if we came up on a problem we discussed the problem and then solved it,"* because *"I understand how to do the problems better when we discuss them together."* Student 19A expanded on this by stating, *"I find that I work better in a particular group in that we listen to each other's views and ideas as to how to work a problem."* Also, *" I prefer to work in a group because you have a better understanding about what you are doing."* Student 20A also endorsed this by stating: *"I liked the last grouping because lately, I found that I work better in a group than by myself, because whenever I don't understand my peers help me."*

Another dimension addressed by Student 9A was that of communication: *"I work better in a particular group because we communicate with each other more and we can understand each other."* Therefore, as a result of the *Coaching Discourses* generated in the groups of students' choice, greater levels of communication were being achieved. Student 4A also endorsed this by stating, *"I like my recent group a lot because we correspond much better."* Hence, *"I like the communication and the working out process in my group"* (17A),*"Since it is slow and easy-going, someone is always explaining; it helps me to understand more"* (11A). *"We could point out each other's mistakes and work better together . . . as we are able to answer each other's questions"* (22A); *"everyone helps the other"* (16A). The rotation of roles in the group-setting helped each student to be empowered in this learning situation.

Student 14A, in explaining what she liked about her recent grouping, stated her preference for the group of her choice:

> *I like my recent group because of the fact that you are placed in a group with your friends or persons that you already know and worked with. So you do not have to go through the process of getting to know them or what they are like, which makes you more comfortable and allows you to work faster and share your views.*

As with their experiences at the beginning when they were first introduced to working in groups, students stated that they continued to enjoy the group-climate generated by the execution of their roles. There was always someone to explain what they did not understand. They were also given the opportunity to agree and disagree, and from the discourses, they were empowered to understand better what they were doing. They also liked the fact that everyone was on the same level; they were peers; they worked together; they listened to each other; they laughed together; and they disagreed together. This form of grouping enhanced communication in this circular relationship and enhanced a climate that did not inhibit their thought processes but encouraged them to share their conceptions and misconceptions and to pool their mathematical ideas. This relationship developed because, according to Student 14A, the group members were friends, and therefore, the hurdles of getting to know each other had already been jumped. They were now able to focus on the task of learning and to do it at a faster rate. Another dimension, cited by Student 2A, was that *"also in this class, you get to find your own way of working out a problem."*

Student' Reaction to Large Group Size

On October 9, Mrs. Scott also asked students to give their impressions of their experiences while they were in the large groups. From a sample of the responses that reflected the general feeling of the students in the class, Student 22A stated:

> *I did not like our recent grouping because we went into groups with people with whom we were not familiar. This caused us not to be so open to the other person's problems. Also, because we were not familiar with their problems, we often passed over their weak-spots and did not discuss them, so some people were left behind and others were ahead of them.*

Being placed in groups with classmates with whom they were not familiar did not engender a caring setting because some forged ahead while others lagged behind with weak areas unresolved. Students were uncomfortable exposing their weaknesses to those with whom they were unfamiliar. Another student, 2A, stated:

> *What I did not like about the large group is that there were too many students in one group, and each student takes a different amount of time to understand a question. Some people will understand a question the first time the teacher explains and some will understand it about the third time. When there are too many students, the teacher will have to explain a question a lot of times, and this can make a person miserable. Some people just don't have the patience.*

For this student, the large group-setting encouraged impatience because the group-teacher had to explain more than once as a result of the different rates at which individuals tended to comprehend. Therefore, the repetition of explanations the group-teacher had to do was not encouraging within this larger group-setting. Student 6A, comparing the larger group-setting with her usual group size, added:

> *My recent group did not think as a group. If they did not understand the question they gave up; even when I understand and I am trying to explain, they act as if they understood, and then they kept looking out of my book, and when I don't understand, they can't help me because they don't understand, too.*

Comparing her experience of the grouping of three persons with that of the large group-setting, Student A6 stated that the level of self-disclosure that existed in the small group-setting did not exist in the larger one. Thus, the level of trust did not match that of the small group, causing individual members to take risks with their group-mates. Therefore, in the large-group setting, many individuals made only a pretense of understanding. From Mrs. Scott's observation of the interaction within each group and from the students' responses, she deduced that the larger group-setting of five and six students did not maximize learning on the part of all students.

Exposing the 4—Arts Girls to the MLE in its Fullness

With Mrs. Scott now exposed to the MLE in almost its entirety, we tried out new techniques with her 4-Arts Girls, making elaborations when necessary during our planning sessions. On October 13, *reciprocal mathematics teaching* (RMT) was introduced when Mrs. Scott had to teach the solution to a quadratic problem by using the quadratic formula. Mrs. Scott taught the solution to a problem using the formula in the whole-class setting through direct teaching. Students then got into the groups of their choice, and each group member was asked to be the group-teacher at a different time. Each member took turns teaching the others the solution procedure to the same or a similar problem using the formula the class teacher had taught. In their groups, students decided who would go first whether by volunteering or by assignment.

The students' reaction to the introduction of RMT reinforced what I had postulated while sharing the idea of RMT with Mrs. Scott earlier. As a result of reciprocating the opportunity to be the group-teacher by providing explanations while the other members of the group questioned the group teacher, students were given the opportunity to verbalize their conceptions and misconceptions as the role was rotated. As a result, students stated that, in explaining, they had a clearer understanding of the solution process; it was as if it were *"registered"* and would not be forgotten readily. Misconceptions were cleared up as the discourses were generated because others were able to help the individual explaining fill the gaps in her own understanding through their questions and suggestions.

Reciprocal Mathematics Teaching (RMT) is an alternative approach to *Mediated Discovery*; in this approach, the class-teacher employed direct teaching; students within their groups reciprocated by employing direct teaching of the same concept(s) while other group members questioned the student who was providing the explanations (**Finding # 24)**.

Students' Reactions to the Introduction to RMT

At the end of the class, Mrs. Scott questioned students, on their impressions concerning what they were allowed to experience.

Mrs. Scott: (directing her question to the group with the student who had been out of school for over two years) *"How did you feel when you had to share with your group?"*

Student: (A member of the group) *"When I had to explain the problem, I find out that I understand it more clearly."*

Mrs. Scott: (reiterated) *"Are you saying that when you explained to others you found that you were learning more?"*

Student: *"Yes, Miss."*

Mrs. Scott: (directing her observation and question to the student who had been out of school for the long period) *"I noticed that you started teaching first, how did you feel about sharing with your group?"*

Student: *"Miss, I liked it very much because it helped me to explain over what I* *understood. It was like . . . it made me ammm it is registered now, so that I will always remember how to do it."*

Student from another group: *"When I taught the other group members, they helped me clear up my misunderstanding and I got the concept better. I think I can do it now by myself."*

Mrs. Scott: (addressing the student who had just responded [This student was not in class at the beginning when the class teacher taught the procedure for the solution] *"You were not here when we started, but from the sharing in your group you are now saying that you are now . . ."*

Student: *"[Understanding.]"*

Another student from another group: *"I found that by explaining to my group, it helped me. Miss, I was making a lot of mistakes but when I got the opportunity to explain it, I got a better understanding now."* (Video, Oct 13).

Mrs. Scott, the Risk-Taker and Experimenter

Getting her class to work effectively in the groups and not taking anything for granted, Mrs. Scott continued to risk venturing on other grounds that led to the effective accommodation of MLE. This was also done by working closely with me as I shared the additional dimensions of the *mathematics learning experiences* and the reasons for the suggestions I made. Mrs. Scott was willing to take risks, and so we were allowed to explore un-entered areas for mathematics learning in this setting. Mrs. Scott was assigned to teach two Grade 10 mathematics classes. She also engaged herself in comparing her 4-Arts Girls with the Science Group – her other Grade 10 class. She stated she was doing this because she really wanted to know if indeed the MLE was making a difference. She insisted on having both groups on the MLP for my data collection. She stated that this would provide me with a comparison between the brighter set of students and her group of 4-Arts girls. The science group was also a mixed group with both male and female students.

The Science Group (4—Science) was perceived by the teachers to be the brightest set of Grade 10 students. The weaker students who did not qualify to be in the preparation group for the external examination (CXC) were not separated from their better performing peers, but Mrs. Scott kept them in this group for the MLE. For the first half of the school term, Mrs. Scott stated that she did not change her method of teaching with this group, but continued her usual direct teaching. She noted that, while the 4-Science group continued to work individually, the 4 Arts—Girls made fewer mistakes than the 4-Science Group with fundamental concepts when they were doing written assignments and quizzes. Also, scores on mini-tests were proportionally higher for the 4-Girls group than those of the Science group. She also noted that the 4-Girls were presenting solutions in more detailed form—an extension of the group discourses (Notes from conversation, Sept. 26, 1997).

Although Mrs. Scott was always very busy, she was accessible; she made herself available between her busy moments, and I was also never shut out from her "psychological space" (Other teachers were not so accessible). Instead of spending her free moments in the staff room, Mrs. Scott spent them in the mathematics room, which was set apart for the mathematics teachers. I also shared this room with the mathematics teachers.

Some of Mrs. Scott's risk-taking ventures served as a data source for other teachers. As she experimented, and whatever she deduced from her experiences, she shared. Examples from each teacher's experiences were also shared with other teachers during their coaching conferences; these served to explain or elaborate an idea or concept. This sharing, I perceived, was another means of dissolving the partitions that had existed previously between the teachers. Thus, Mrs. Scott's experiences with the effect of the random grouping, groups larger than three, and other aspects of the *mathematics learning experiences* were all shared with the other teachers. As a result, other teachers did not do further experimentation but took on the techniques that worked best for Mrs. Scott as their starting point in their own situation since they all started at a later date in accommodating the MLE. Hence, Mrs. Scott's experimentation served as the ground for decision making for the other teachers.

A General Overview

In our meeting on October 14, Mrs. Scott gave a general overview of what was happening in her classes. She stated: *"Students are making connections"* not only within various topics in mathematics but also with other subjects as well. They had become efficacious. Before she reached her classes, her Grade 10 students were already in their groups and working out problems on their own. They selected problems they were having difficulty with and worked them out together in the whole-class setting before she got to the class. Mrs. Scott went on to state that students were doing so many problems on their own that she was not able to keep up with the marking. Therefore, they exchanged workbooks and marked them. Each student who did the correction had to sign his or her name so that if and when Mrs. Scott got the chance to go through the books, each would be held accountable for any discrepancy in marking (Notes, Oct. 14).

Mrs. Scott also shared her experiences with her other groups. She stated that she observed, especially with her Grade 11 students, that *"they were forcing others to think of alternatives –another way for solving a particular problem."* She explained that, within the groups, they were asking each person to come up with a different way of solving the same problem. This added dimension was occurring naturally with her 4—Arts Girls among the groups, but with the Grade 11 students this feature was taking place within each group.

The students, in all the classes with which she was using the MLE, were also not looking to a particular person in the class for the correct answer because they were perceived to be brighter by their class mates, but it was what each was able to do for himself or herself, or what they could do among themselves within the group that was important (Notes, Oct. 14). According to Mrs. Scott, the grade was not the most important thing anymore; what mattered was what each individual was able to do. As a result, the chronic problem she had with cheating because students always wanted to obtain a high score no longer existed (Notes, Oct. 14).

Another dimension was that students utilizing the questioning technique—the mediation—were giving more detailed explanations in their verbal presentations. Because students were providing more detailed verbal explanations, I further suggested to Mrs.

Scott that explanations could also be included in the presentation of their written work. Thus, they could provide not only step-by-step solutions but also explanatory statements beside each step in the solution process. This additional element of the *mathematics learning experiences* became an added feature to the students' solutions to problems. Even though writing was not an art enjoyed by all, Mrs. Scott used the written explanations as an incentive for awarding bonus marks initially to get students to write explanations as an integral part of the solution process of the problems.

Four Science Class

During the professional development session on October 22, each teacher felt free to ask questions of the other. During the session, a dialogue developed between Mr. Lennox and Mrs. Scott. Mr. Lennox, having had to teach the 4—Science group of students, noted the difference in the way they were asking questions. He was curious to learn whether Mrs. Scott had been using the approach with that particular group of students also. He queried: *"Have you started the Coaching Approach with the 4—Science?"* Mrs. Scott's reply was *"Not all aspects of it."* Mr. Lennox continued to give the reason for his question: *"I must mention this, that I was so impressed with the way they ask questions."* Mrs. Scott explained that the seating arrangement in the science lab was not convenient to have the students work in their small groups. Therefore, *"they were doing it differently."* However,

> *They have responsibilities. They question each other and they are more in pairs. They decide the questions they want to ask so . . . we started by emphasizing different aspects of it. They would be at the board, and three different persons would be working the same problem, but they would be using three different approaches. This is how they are. In terms of the three in a group, the space does not allow it, but all other aspects, yes. (PDP, Oct. 22, 1997)*

Mrs. Scott's 4-Science class met in the science laboratory for mathematics. They did not have the luxury of sitting at their individual desks or being able to move around as they wished. The long working tables in the science lab proved to be an obstacle for them to enjoy the grouping arrangement that the MLE necessitated. Mr. Lennox queried about the impact of the aspects Mrs. Scott had so far introduced. Mrs. Scott continued to explain what had been taking place: *"They interact; they don't have a fixed group; . . . they interact with the first person beside them. They can't do that with a third person because of the seating arrangement."* Therefore,

> *before the class begins there is normally an informal situation where they interact with anybody in the class. So you will come to class and the first thing you may see is some little bunches all over the place for the first 10 minutes of my class . . . so this is a big-group situation. But all the other aspects have been implemented. The questioning, the coaching, but not the grouping. (PDP, Oct. 22, 1997)*

Mr. Lennox continued to solicit her impression of what was happening to this group. His next question was, *"What impact will it have on their math learning experiences?"* Mrs. Scott's reply was,

> *For this Science group, it forces them to investigate; it forces them to question; and I am doing my probing and mediating. . . . They are forced to look into a topic first; afterwards they attempt it, then I come in and clue them. So it forces them to think that way."*

Mr. Lennox continued to solicit his Chair's impressions of the program with this particular group; his further query was, *"Do you see ourselves finishing the CXC syllabus?"* Mrs. Scott, ensuring that Mr. Lennox was referring to the use of MLE, allayed his fears:

> *I think that was our biggest fear, to see whether or not we were going to finish the syllabus, but . . . I think we are really going extremely fast; . . . using the former method, that slowed them down, but this is their pace they are setting, so they are going ahead.* (PDP, Oct. 22, 1997)

To this response, Mr. Lennox's concluded: *"So the coaching has really revolutionized math learning!"*

By November 20, Mrs. Scott had done some creative work in the laboratory by arranging the long lab benches in an alternate manner so that students could have their groups at the short corners of these tables. They were able to give their reactions to the groups of which they were a part. They stated that they liked *"the co-operation between each member," "the interest each member gives," "how the group worked together as a unit,"* and *"as a team, with every member playing his or her part." "We are very active and co-operative."* According to Student 10Sc (Nov20), *"the fact that we all decided to co-operate and work together in unity . . . we were able to be successful in aiding to* *strengthen our weaknesses and sharpen our skills."* Also, *"I like the way we are able to put our ideas together and conclude on one point"* (3Sc).

An advantage, which was stated by Student 001Sc, was *"the way we were placed together; this helped me to ask questions instead of asking the teacher in front of the entire class."* Also, *"by asking each other to put in their opinions about how to solve the questions"* (011Sc), *"we all got to express ourselves and share our ideas with each other"* (14Sc). So *"I like the way we all took part in something for solving the equation"* (5Sc) *"and how we pooled our information"* (002Sc) because *"it is easier communicating with my friends and I understand faster when they explain"* (12Sc).

One student stated: *"The different levels of thinking within the group helped to increase my understanding of the lesson and also helped me to recognize simple mistakes that I was always making"* (010Sc). It was no longer the teacher identifying and pointing out errors but students working together within the group, *"There was always someone who would point out an error or mistake"* (005Sc). So *"We all pitched in here and there, and this made it a bit easier to understand the problems, since we all explained them in a different way"* (6Sc). Hence, *"By working together, we were able to reach a conclusion by using each other's method of understanding and evaluation"* (011Sc).

They also stated that the questioning technique employed in the groups enhanced performance because *"Thinking about the question helped my performance because being able to ask each other questions opened my mind more to the subject and helped me not to approach anything with one direction"* (14Sc). Student 008Sc also stated, *"I understood by asking questions about the concepts involved in solving the equation which I wasn't really clear about,"* and *"asking each other questions helped me to understand better and also to understand my work better"* (1Sc). Also, *"Asking each other questions helped me to put forward a solution more quickly"* (9Sc).

The questioning served to raise the students' consciousness. According to student 12Sc, *"It affected my performance positively because I had to explain everything I did and I had to plan and explain the concepts."* Doing so also had long-term implications because the 4—Science students like the 4—Arts Girls were now presenting their work in a more logical order and were also providing written explanations during the solution process (see **Appendix H**—students' solutions of problems –a sample).

Students also stated that although their minds were somewhat blank at the beginning of solving a problem, asking questions and offering explanations helped. According to Student 008Sc, *"When I really thought about it, I was able to contribute in solving the problem."* Student 11Sc validated this by stating that *"Explaining helped me to understand the steps that I did not understand and therefore enabled me to perform better."* According to Student 2Sc, *"It also helped me to perform well because I get to learn different methods of solving a problem."* Student 11Sc asserted: *"I can invent my own method or procedure of doing a particular question."*

According to Student 007Sc, *"You can ask yourself or someone in your group a question that shows that you are understanding the concept." If we had similar ideas and thoughts on the question, I could therefore compile my knowledge and perform better"* (3Sc). *"The group has also helped to motivate me in doing my work"* (1Sc).

Mrs. Scott, having ingeniously thought of a way to overcome the obstacle that the limitation that the classroom facilities afforded, introduced the science students to the roles and grouping of their choice. Like all other groups, their reflection on their experiences brought similar conclusions. Students reported that co-operating, working together as a team, being very active, pooling their ideas, asking questions, and communicating with their friends contributed to their learning and understanding. Also, the contribution of each with his or her various levels of thoughts aided in comprehending whatever they had to do. The recognition and the pointing out of mistakes, the explanations, and the planning enhanced their overall performance as they were even able to invent their own method or procedure of solving a problem. Doing so also motivated them.

A Summary of the Students' Perception of Their Experiences

Grouping by students' choice provided students with the opportunity for friends to work together, to laugh together, to listen to each other's views, and to be interested in each other to ensure each understood through team-work and co-operation (**Finding #**

25). Grouping by students' choice, with the assignment of roles, provided a setting where each is active in his or her role and contributes to the solution of mathematical problems through pooling ideas and opinions, motivating each other, communicating better with each other, and helping each other not to approach solutions in a one-track way (**Finding # 26**).

The employment of the roles in the groups promoted feelings of equity in terms of the opportunity and freedom to ask questions, to give and accept explanations, to talk and share thoughts and ideas so that students could give and receive help from their peers and build the confidence in themselves that they had the ability to accomplish mathematical tasks **(Finding # 27)** (interdependence builds efficacy). The employment of the roles helped students to strive for excellence and mastery of the subject and generated a comfortable setting for them to share their views, discuss, agree and disagree; identify and expose their own as well as others' weaknesses and mistakes; strengthen their problems-solving skills to grasp principles and to understand problems and solutions better; and to make mathematics interesting and understandable (**Finding # 28** roles: Craftsmanship).

Random grouping with group sizes of three provided students with the opportunity to choose for their working-groups friends whom they felt comfortable to work with; larger group sizes did not engender the same level of caring and maximum participation because students were grouped with those with whom they were not familiar, and so they were not as open and concerned about one another, weaknesses were unnoticed, and they did not think as a group (**Finding # 29**).

Questioning helped students to improve their understanding and performance by allowing them to have open minds and by providing them with opportunities to recognize their errors, to seek clarification, to investigate, to invent their own methods of solution and to provide explanations for problems, for solutions, and for decisions made (**Finding # 30** Questioning: craftsmanship). Explaining aids understanding and performance by providing opportunities for students to communicate and comprehend what was not understood, to clarify misconceptions, to grasp concepts better, to enhance communication, and to overcome weaknesses and the tendency to make mistakes

(**Finding # 31** Explaining: craftsmanship). Providing explanations presented different levels of thinking that aided understanding and helped the individuals explaining to have a clearer understanding as their thoughts and ideas were verbalized (**Findings # 32**).

Further Explorations

Mrs. Scott continued to work with her Grade 10 groups, utilizing the *tools* of MLP we thought essential for the success of the program. She continued to introduce and explore these *tools* with all her other classes at the Grade 8, 9, and 11 levels. We also extended the *mathematics learning experiences* to include the use of manipulatives at all levels.

After feeling comfortable that her students were not only exposed to these *tools* but were also utilizing them effectively in the mathematics learning context, Mrs. Scott began a coaching partnership with Mr. Lennox who was now her coach. However, Mr. Lennox did not reciprocate. Mrs. Scott's chief objective for this coaching partnership was to identify and improve her weak areas. During the planning sessions with Mr. Lennox (See **Appendix G**), she asked him to focus on and collect information concerning areas she considered her weaknesses, for example, her questioning. She had identified the type of questions she was asking as a weakness, noting that she was too directive or telling in her questions. Hence, she wanted to improve. Also, Mrs. Scott was now coach for one of the new teachers to the department, Mr. Interesteed. The objective was to begin to share with the teachers who were not yet exposed to the coaching process.

CHAPTER SIX[5]

THE GENERATION AND DEVELOPMENT OF THE MATHEMATICS LEARNING PROGRAM (MLP) Contd.

> *We have been placed in groups in which we were given different roles such as teacher, questioner, and recorder. Less pressure was placed on us by the teacher as we did not have to face her with our uncertainties. . . . These principles have helped us all and we have all learnt to accept mathematics better. We have also learnt to understand the mathematical concepts better.* (22A, Dec.8)
> *I feel more relaxed and comfortable when working in my group because I can share my ideas and I work more efficiently. I have played all the roles in my group, and I am comfortable with playing the role of the teacher; . . . it is like I am in charge. I pool my ideas with my group members and they give me feedback if I am wrong.* (13GA, Oct.13)

The findings in this chapter, in addition to those in Chapter Five, serve to address the research question: "*What were the teachers' and students' perceptions of the generation and development of the Mathematics Learning Program (MLP)?*" The case studies of three of the four teachers' experiences with their classes on the *mathematics learning program* (MLP) are presented. Each case includes the initial individual translation of the teachers' PDP experiences in the classroom, their initial cognitive coaching conference experiences, their accommodation of the *mathematics learning experiences* (MLE) in their classes, and their class(es)' perception of their MLE. The final section overviews the four teachers' and some of their classes' reaction to their experiences with the MLP.

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[5]

a. A version of this chapter has been prepared as part of a paper presented at the April 1998 American Educational Research Association Annual Meeting, San Diego, California, U.S.A., and has been published. Mclymont, E.F. & da Costa, J. L. (1998). ERIC Document Reproduction Service ED 420 637

b. A version of this chapter has been prepared as part of a paper presented at the 1998 International Multicultural Conference University of Alberta, Canada, and has been published. McLymont, E. F. (1998). International multiculturalism 1998: Preparing together for the 21st century, pp. 236 - 250.

c. A version of this chapter has been prepared as part of a paper presented at the 3rd African Society Conference 2000: Prospects for an African Renaissance. University of Alberta, Edmonton, Canada. February 2000.

CASE II

MRS. SINCLAIR AND HER CLASSES

Mrs. Sinclair's Initial Experience to Generate the MLE With Her Assigned Class

Teachers were given the opportunity for personal and individual translation of their PDP experiences in their classrooms during the first few weeks of teaching at the beginning of the school term. Each, in a unique way, sought to take on aspects of this alternate approach that were used as *tools* for effective *Discourses*. Teachers chose at least one of their classes to employ the principles with and to share and pass on to their students the *tools* they had embraced. During my visit to the school on September 15, teachers stated that they were employing aspects of the approach in their classes.

At the September 22 *professional development* (PD) session, Mrs. Sinclair stated that she, too, had been working on some aspects of the MLE in her classes. She was focusing on the *tools,* for example, paraphrasing and the other aspects which went along with it, such as listening to the students more:

> *Like the listening, we are listening to them and we are doing that in all our classes. Some of the paraphrasing, sometimes when we are introducing a new concept we try and paraphrase and see what we can get done. And in grouping, we try to get them to work together and they have a questioner and a recorder, but they are working it out among themselves.* (Sept. 22)

For Mrs. Sinclair "*one more new dimension*" that had been added to her teaching was "*to listen to the students more.*" So, with a focus on listening and paraphrasing, she was also trying another new dimension: "*Well this is not so new; recently we have been emphasizing it in lower school; that is the grouping. But now we are doing it in upper school, the grouping of students for them to be sharing their ideas and methods.*"

Mrs. Sinclair's approach to grouping was not similar to Mrs. Scott's approach. While she assigned the roles of "questioner" and "recorder" in her Grade 10 class, students were left to themselves to work out specifically what their roles involved. Mrs. Sinclair went on to state: "*What I find also is that once they have paired with someone,* *they don't want to leave that person, . . . it is like a partner for life.*" Mrs. Sinclair's students gravitated to the group partners of their choice. As with her experience in the seminars in which the teachers worked mainly in groups of two, Mrs. Sinclair reported that she was trying to have her students work in pairs also.

Mrs. Sinclair went on to express some difficulties she was experiencing with the introduction of grouping with her class: "*We are doing it in upper school, the grouping of students for them to be sharing their ideas and their methods.*" But was finding it "*very difficult,*" Mrs. Sinclair admitted:

> *One is working the answer and telling the others. We want to move away from that to where they are really together and working it out saying it together and coming up with the correct response. I don't think I have reached that aspect of it. But just for them to sit into groups and not fighting and struggling we are at that aspect. In some groups some of the students are still relying on the brighter ones or the ones they think understand the concepts more to work out the problem and then to show them.* (Sept. 22)

Being grouped without the assignment and employment of specific roles, the students did not change their behaviors. The usual situation in the class, the students' being dependent on those whom they perceived as bright and whom they thought understood the concepts better than themselves, did not change. Although students were sitting in their groups, they were not working together as a group.

Learning what was happening in her situation, I used the self-prescribed verbal strategy (Costa & Garmston, 1994) that might enhance her efficacy by inquiring, "*What sort of things do you do to help these students to move away from depending on others or on the teacher and to rely more on themselves?*" Mrs. Sinclair's reply was, " *I think I have to develop my question bank . . . what are the objectives? How are you going to find the answer? Little clues like that to help them, sometimes I do it sometimes I don't.*" To this response, I reminded Mrs. Sinclair: "*Within the group, that is the whole function of the questioner.*" This was followed by a reminder of our objective for the MLE to empower each student to develop his or her mathematical potential.

On the other hand, however, Mrs. Sinclair went on to explain that the narrow worlds of individuality that enclosed her students were beginning to be transcended by acts of collaboration, probably initiated by the natural elements of the weather. She related her story:

> *With my fourth form* [Grade 10] *this afternoon, because of the lightening, I went to tell Mrs. Mac to remove her car and the rain caught me on that side of the school . . . and when I came back they were all working together as one B-I-G group. The students got a partner and every work they did, they checked. The lightening was flashing and the rain was blowing in, so they move into O-N-E B-I-G group, almost circular, and they were there working away.* (Sept. 22)

Mrs. Sinclair also mentioned other aspects she was working on with her classes:

> *I am trying with the holistic development of the students (laughs) but I don't know if I am getting very far with that. But I am trying to see each child as an individual; what talent he has, what aspect of the program he is understanding, and how to help to use that to build on. . . . One more new dimension is to listen to the students more, and I am also trying not to be judgmental (laughs).* (Sept. 22)

Mrs. Sinclair was making the effort to cater to the whole person in the classroom, seeing each child as a unique individual and noting the contributions each can make to the learning situation. With her consciousness raised with regards to the rejoining of the emotions and the intellect, she stated that she was also removing the judgmental comments from her classroom discourses. She was trying not to demean her students and was helping them also not to demean their classmates: “Y*ou try not to say terms like... 'stupid!' 'Rubbish!'*” Students also *“know that when someone else* (any of their classmates) *is speaking, they cannot shout and say 'No you are wrong!' and things like that.*”

Mrs. Sinclair also used the questioning techniques to help students elaborate on their thoughts and to explain their thinking instead of putting a value judgment on students' responses. This, she admitted, was creating a more relaxed and trusting atmosphere in the classroom. She stated that some questions that she was asking included the following:

> W*hy do you think like that? Tell me how, explain to the class, because they help and they eliminate some of the cobwebs in the students' mind, . . . and because you allow them to speak, they are far more relaxed now in the classroom.*” (Sept. 22)

She also noted that her fear of losing control when disciplining the students was also relieved by the use of the *tools*. However, *"discipline is still there, but it is not as regimental as before."* In this situation, students were not kept in a straight jacket as it were by the "whip of the tongue" but were now being treated as unique individuals with a voice of their own.

Embarking on a personal and individual translation of her PDP experiences in the classroom, Mrs. Sinclair started to initiate her students to grouping and to utilize the non-judgmental verbal and non-verbal responses by giving voice and listening to her students more to generate respect for one another's ideas, and to create a relaxed setting to allow students to think and clarify their thoughts (**Finding # 33**).

Creating a Climate for Alternate Approaches in Mrs. Sinclair's Grade 10 Class

After launching off on their own, the teachers saw the need to utilize the additional *tool* of conferencing so that they could be coached in order to maximize and hone the use of the *tools* embedded in this alternative approach. At the September 22 PD session, after being informed about what was being done in the classroom, I was invited by Mrs. Sinclair to observe what was taking place in her classes. She informed me that the teachers had not chosen their coaching dyads, but reassured me that *"When the new timetable is out we will have the new coaching cycles."*

Consequently, on September 25, I visited Mrs. Sinclair's Grade 10 class—4 General. Mrs. Sinclair, using direct teaching, taught the solution to simple equations. After the teaching session, she asked students to get together in groups of three. She assigned them the roles of "teacher," "recorder" and "questioner" with the duty of each written on the chalkboard. The teacher should read the question or mathematical problem and ensure that each group member was actively involved in solving it. The questioner should ask questions such as: "What is our objective? How are we going to find the answer?" And the recorder should write the responses and suggestions for the solutions. After explaining the role of each, she asked each member in a group to model his or her role. The students modeled their roles. She then assigned a simple equation to be solved and students assumed their roles in the groups. This was the first time grouping of this nature was introduced to this class. To me, the questioning in the group-setting at this initial stage seemed stereotypical and mechanical, but it seemed to "break the ground" for further questions and to gain students' attention to focus on the problem and to initiate the active participation of each student. This way of questioning became the norm for initiating each group's problem-solving activity for subsequent lessons and for engaging students in thinking aloud problem solving as the group-teacher would read the problem and the questioner would ask: *"How are we going to solve it? What is our objective?"*

Following the lesson observation, Mrs. Sinclair wanted to know how her teaching was from my perspective. I reminded her that one of the purposes of conferencing is for both individuals to be aware of the data to be collected during the observation, and since did she not ask me to collect specific data with regards to her teaching, I could not provide her with any information. The objective of the observation had been to see what was happening in the class and for me to learn how they were doing, whatever the topic was, and to get a feel of classroom climate and to meet the students. Therefore, I did not offer any judgments; I was also learning to postpone the passing of judgments so as to allow her to feel comfortable with my presence. I continued to visit all Mrs. Sinclair's classes—Grades 9, 10 and 11. She was still using the direct teaching method. By first week of October, she had decided that she wanted to be coached for her 4-General Grade 10 class. The new timetable for the mathematics department was out during the first week of October, and so the first coaching dyad between Mrs. Sinclair and Mrs. Jacobson was formed with me as co-coach.

Mrs. Sinclair's First Cognitive Coaching Experience

The Planning Conference

On Tuesday, October 7, Mrs. Sinclair had her first formal planning session. Mrs. Jacobson elicited information on the topic "solution to inequations," which included the objectives, the concepts, the mode of delivery, the anticipated activities that she planned to employ during the lesson, and the alternative strategies that could be utilized. Assuming my role as co-coach, Mrs. Jacobson and I began by probing for specificity and mediating for alternatives. With the usual laughter that attended all our sessions, the alternatives were explored and with further probing, I mediated for how an integral aspect of the *mathematics learning experiences* (MLE)—the group activity—was going to be incorporated in the lesson. Mrs. Sinclair's reply was, *"I think we will do it together on the board. I don't know. What do you think?"*

Together we explored how to incorporate the group activity by planning to arrange students in their previously assigned groups with their assigned roles and give them problems to solve. An elaboration was made that, during the lesson, each group with a different method of solution could be asked to share the group's solutions in the large group-setting. Also, together, the whole class would decide on how feasible the solutions were and would seek to explore the different solution paths taken by each group. With this suggestion, Mrs. Sinclair decided that she would try it. Again, together, we explored the reason for this technique; it was deduced that like the experiences of the PDP, the key element was *"to maximize student participation . . . where everyone would be involved in their own learning."*

The number of concepts Mrs. Sinclair had planned to teach in this one lesson on solving inequations seemed overwhelming. So I listed the concepts I had deduced from what was suggested by the various activities then queried whether too many were being attempted at once. With much laughter, Mrs. Sinclair, like a child, exclaimed: *"I don't know what to do!"* Then she proceeded to think of some concepts she could eliminate and then exclaimed: *"But I want to do them all!"* She could not think of specific ones to eliminate. Through questioning, we continued to explore the details of what was involved in each activity. With her consciousness raised about the details involved, Mrs. Sinclair decided: *"No! (Laughs) It will be too complex."* So fewer concepts were decided on.

Mrs. Sinclair, being made clear somewhat on the details of what she would be doing in the particular lesson, gave a summary:

> *So when I go in Thursday morning, I just give them the problem to solve within their groups. From their responses, I take up from there, do a little direct*

> *teaching, and from there I put them back in their groups to solve other problems.* (Plan. Conf. Oct. 7)

Mrs. Sinclair, reflecting on the process of the planning conference, was overcome by much laughter. She stated: *"It forces me to sequence my teaching, to know exactly what I am going inside the class to do, and to know how I am going to teach—the method"* (Planning Conf. Oct. 7). We also decided that the focus for data collection would not be restricted to what the teacher might request but data concerning the salient elements of the MLE would be collected since we were focusing on the accommodation of the *mathematics learning experiences*.

Through questioning, the planning conference "forced" the sequencing of concepts and activities, led to thorough preparation, served to clarify details, and helped Mrs. Sinclair to know exactly what she is going into the classroom to "teach" (**Finding # 34**).

The Lesson Observation

On Thursday, October 9, Mrs. Sinclair, in a unique way, led the class into a sample small-group problem-solving process for the introduction to her lesson. This was not part of what was planned during the planning conference. To introduce what she wanted to teach, a student asked: *"What is your objective?* Mrs. Sinclair explained her objective and then she asked: "Who would like to 'coach' me now?" Another student volunteered to coach her through the solution to "$V^2 = U^2 + 2ax$," solving for x. After the solution to "x" was found, she wrote the inequation "$2x + 3 \geqslant 10$" on the chalkboard and asked students to solve it. The groups approached the solution differently. Some worked individually and when they came upon difficulties, they questioned each other; others worked together with one person writing what the other members were suggesting. Some students tried working it two ways, both with an equal sign as well as with the inequality sign, setting up a parallel as it were. After some time, Mrs. Sinclair asked if anyone had come up with a solution. Students were timid to share what they came up with. She looked at one group's work, saw that they had a solution, and requested that they share it.

The procedure for the solution of the inequality was shared in the whole-class setting. As many groups had done, moving from what they knew to the unknown, Mrs. Sinclair used their idea of solving the corresponding equation $2x + 3 = 10$ and then she asked the students to give her the similarities and the differences they observed between the two sets of solutions. A detailed comparison was done.

Students were then asked to represent the inequality on a number line. After working in their groups, a group shared their solution and it was accepted. For the next concept, Mrs. Sinclair reverted to direct teaching. She did not give the students the opportunity to attempt it on their own in their groups, but used direct teaching to demonstrate how the same inequality could be represented on a Cartesian plane. She also told them the reason for the use of the solid line or a broken line. Students were then asked to graph "$4x - 2 < 6$" in their groups.

The Reflecting Conference

After the lesson observation on October 9, Mrs. Jacobson and I engaged Mrs. Sinclair in her first reflecting conference. Signaling a trusting atmosphere, I started the reflecting conference by showing positive personal regard with respect to the observation of the act of having the students "coach" her during the lesson and to solicit her impressions about this action. Mrs. Sinclair's response revealed her objective for the unique employment of this *tool*, the questioning technique. She stated:

> *I like it because I understand better how they will be questioning each other within their groups and to see if they are understanding the questions and how to go about working out a particular problem. So when they coach me now, I know if they are asking the appropriate questions and if they know how to go about solving a particular problem.* (Reflecting Conf. Oct. 9)

Mrs. Sinclair further explained how she felt the coaching of the teacher by the students would influence the questioning in the small group activities. She stated:

> *They will question their group members some more now. If a group member says this is right, then they will find out from the group member why it is right. "Why did you do it like this?" Or "How is it done?" Or whatever. I think this will happen.*

Mrs. Sinclair was making the necessary preparation for maximizing the students' participation within their groups by having the students "coach" her in the whole-class context. Soliciting how she felt about empowering the students with the use of the questioning technique and if she felt threatened by this empowerment, Mrs. Sinclair's response was a definitive

> *NO! I think I am being empowered because it is helping me to think and to prepare more. (Laughs) Even this one we did not introduce it this morning negative $3X < 12$ therefore $X > -4$. Usually I would just pass over it and say when you take it across the inequality sign, but now . . . (laughs).* (Reflect. Conf. Oct. 9)

But now she was anticipating *"The question!"* Mrs. Sinclair laughed. Therefore, the concepts she wanted the students to understand she, too, had to conceptualize. Elaborating on this, she explained how having the students "coach" her was influencing her preparation for the class because she, too, was no longer afraid to solicit another teacher's ideas on concepts she was not clear on:

> *Even this morning before the class I asked Mr. Lennox, I said: "Mr. Lennox come tell me what to tell the students when they ask me 'Why?'" So we tried to work it out and find out the explanation. We explored several explanations. But I did not like some until he said: "ok, substitute something there, for example, negative 6." So negative 3 times negative 6 would be positive 18. 18 would not be less than 12. So they will see the necessity of the sign change. So I decided that no way would I go into the class and not have a reasonable explanation. Especially that dark girl Sefta she would tix me. I know she would tix me. Even if the other students would not tix me I know she would. When I reached the class I realized I still had too many concepts to do so I did not do the negative X wherein they would have to change the inequality sign. So tomorrow I would do that.*

Mrs. Sinclair was not taking anything for granted. She would not risk going into the class without having an explanation for the anticipated questions from her students whom she had initiated in the unique way of having them coach her. There was no retracing of steps on Mrs. Sinclair's path. For the concept that she stated she would be doing the next day, she decided she would use the same approach. She "*would let them try to come up with it instead of me telling them.*"

From the observation of students' behaviors, it was also noted that students were making deductions on their own. Mrs. Sinclair went on to express an observation she had made: "*What I noticed during the class was that they recognized that the solution set goes on to infinity without my telling them that was so.*" The need to empower students to provide explanations within the group-setting was also explored. We also explored how she could develop this technique to further empower the students by having them coach her naturally instead of only when she solicited the questions.

From the data collected, several other issues were explored. Mrs. Sinclair communicated what was important to her. For the planned procedure to have solutions to the problems explored in the small groups, Mrs. Sinclair asked: "*You remember the alternative method that you had suggested. Instead of my telling the students, you said 'let them come up with it'? Should I ask you what you think or should I tell you what I think?*" (Laughs)

We gave Mrs. Sinclair the opportunity to give her impressions on that particular aspect. She explained:

> *I think it went across very well. Most of the groups were able to come up with the correct answer; some of the groups had changed the inequality sign to an equal sign and then changed it back when they reached the final step. I think to solve the inequation went over well!* (Reflect. Conf. Oct. 9)

As we probed for her impressions on specific aspects, Mrs. Sinclair provided data to reinforce her impressions. Based upon what the students were able to accomplish, Mrs. Sinclair's impressions were further solicited. She stated:

> *Because of the way we introduced the concepts, the whole method of solving the inequation was out of the way in a few minutes. So we were able to do other things. . . . Even though they did not get to practice many problems, in my mind, I think they understood what to do, because most of it came from them. And they were very sure of the explanations they gave. Also, how they verified each explanation was good. What I do tomorrow will be more graphing. They are weak on the graphs.* (Reflecting Conf. Oct. 9)

As we provided data for other occurrences in the classroom, we continued to share our impressions. Mrs. Sinclair continued to express her elated feeling concerning the number of concepts which were "uncovered" during the lesson. She also continued to explore how her "states of mind" (Costa & Garmston, 1994) had influenced her behavior:

> *For interdependence, the students and I were sharing; I think that part was good; . . . I was perfecting my craftsmanship. I was thinking about the lesson since the planning conference. I even made notes last night. I did not follow it religiously because as the questions were asked, I would switch to something else. Certain things which I would have taken for granted I thought about it and tried to sharpen my skills where that was concerned until I was satisfied that I could give a reasonable explanation for them. For example, that is why I went to Lennox this morning before the class. Because I usually do this thing mechanically but because the children are going to ask "Why?" I needed a reasonable answer; so this raised my level of consciousness. I realized that I needed to know "Why" myself. So I was perfecting my craftsmanship and this made me more confident—efficacious!* (laughs). (Reflecting Conf. October 9)

Mrs. Sinclair was questioned about decisions she did not plan for but had to make during the class session. These decisions, she explained, addressed how flexible she was:

> *Yes, especially when we were dealing with the number-line and the graph and we had the "less than and equal to" sign, I had to switch and separate them for the students to see the difference. I was doing it together and I realized that I had to switch and do them separately. So I was addressing flexibility there.* (Reflecting Conf. Oct 9)

On her impressions of the students' response, Mrs. Sinclair chimed: "*Oh! After that they grasped it! So my efficacy was boosted. Interdependence was high because they asked the question and that helped me to clarify certain things and even some of the questions they were answering themselves.*" Mediating for any other impression of any aspect of the class that we did not tap, Mrs. Sinclair stated:

> *I felt that the students were really with it. I felt that they were a part of the whole teaching not only the learning, and they were helping one another. Even though they did not do many problems, I felt that they have conceptualized what we set out to do. I felt that understanding was there and it was not mechanical no! no! no!* (Reflect. Conf. Oct. 9)

Mentioning the word "mechanical" triggered thoughts of another observation I had made. Students were still very dependent on the teacher to tell them certain things. In their groups, they were asking the questions mechanically and stereotypically. The questioning, though it prompted the students to be thinking ahead and to be thinking about the solution to the particular problem, did not flow naturally like a conversation. However, it empowered the students to ask each other questions without being afraid to do so. It also empowered students to see that it was okay to help others. Thus, barriers were being broken down because this use of the roles led students to ask questions freely of each group member when they came upon a snag. It was okay to ask questions of their peers. The responder saw it fit to stop whatever he or she was doing to respond to whatever was solicited (Notes, October 9).

Mrs. Sinclair, however, was still dominating the teaching situation by doing mostly direct teaching and "putting words in the students' mouth," that is, by giving prompts for certain responses. This observation, Mrs. Sinclair stated, she recognized about herself and had taken on a particular solution path for this problem. She stated: *"That is why I started to have them coach me to see if I could get them to ask more questions within their group."*

Using the teacher's terminology for the mediatory kinds of questions—"coach"—the students, encouraged to coach the teacher during the lesson in the large-class setting, were initiated to the kinds of questions they should ask one another in their small-group setting (**Finding # 35**). Students' "coaching" the teacher serves to empower the teacher as anticipating the students' questions, she sought various means to conceptualize the concepts she was inviting the students to learn (**Finding # 36**). Being initiated to the alternative approach, students, in their small groups, were able to "uncover" mathematical concepts leading away from mechanical learning to conceptual understanding (**Finding # 37**). The "states of mind," utilized as *diagnostic tools* by teachers, served as the means used to examine teacher's and students' behaviors during the employment of the alternative approach (**Finding # 38**).

Mrs. Sinclair's Continued Exploration with MLE

On October 13, there was a minor change in the timetable, making it impossible for Mrs. Jacobson to coach Mrs. Sinclair. So the decision was made for me to coach Mrs. Sinclair for her 4—General class. I decided that I would do so, but I would give her autonomy in having her coach herself as early as possible in this experience. So I coached

Mrs. Sinclair for the class of Thursday, October 16, mediating for all the key points discussed in the previous planning and reflecting conferences. The topic was "solving simultaneous equations." We decided that we would use the approach in which the teacher would not do any form of direct teaching but would have the students use their previous knowledge to derive the solution to the problem "$x - y = 2$ and $x + y = 8$" by any method they chose.

From my observation, I could not help being judgmental. This was what I would call a "near perfect" *Mediated Discovery* Lesson. Students were given opportunities to explore the solution to the problems without being told anything by the teacher. The role of the coach that each student had embraced, I think, was working very effectively.

The topic under discussion was the solution to simultaneous equations. Students came up with different solutions to the problem posed. The groups came up with the methods of elimination, substitution, and trial and error, and one group came up with multiplying the equations by 2 and then adding them horizontally to eliminate one of the variables. After the groups shared what they came up with in large-class context by writing their solutions on the chalkboard and explaining what they had done, Mrs. Sinclair allowed them to identify similarities and differences among the solutions. They were also led to deduce what "simultaneous" meant as they were told that the pair of equations were called "simultaneous equations." Students were then given other systems of equations to solve within their groups using at least two methods, the method of elimination and the method of substitution. At the end of the class, students did not want to leave. Although they were now able to solve the system of equations using at least two methods and they saw that they could arrive at the same solution set when it was solved both ways; they wanted to continue to solve other equations.

Mrs. Sinclair's Reflection on Her "Almost Perfect" Class

Mrs. Sinclair began the reflecting session by providing a summary of her impressions and an assessment of the classroom event:

> *The students achieved the objective with little or no help – no direct teaching from the teacher. The teacher was really a facilitator in this particular class. Just to*

> *guide them where they were going off on a tangent. But I think on the whole the students really set out and really tried to achieve the objective with little or no help.* (Reflecting Conf. Oct. 16)

Knowing that Mrs. Sinclair was just trying to smother her feelings about the class, I asked: *"So how do you feel about this class?"* Mrs. Sinclair laughed, and then said:

> *I feel good. I feel good, because here I was . . . usually when I am teaching simultaneous equations I would really do the direct teaching to be quite honest with you, and it is a topic that I like to teach. So I would really do the direct teaching, but in this class the children pulled from what was in their math skills within them to solve the problem. It was as if there were no fears. It wasn't as if "Miss, it is hard." They really wanted to try and solve it their way. And I really liked the group that came up with the trial and error. I think that is really a good way of solving mathematics problems sometimes—the trial and error method. The other students really used their previous knowledge, I think, to help them to solve the equations. The mere fact that they had been doing all of these simple equations and transposition in formulae, it just tied in with the simultaneous equations. I think it helped them. You could see the build up. What I noticed now is that the mechanics of solving a simple equations have disappeared. They all can solve simple equations now and they are using that skill to move on.* (Reflect. Conf. Oct. 16)

Mrs. Sinclair, feeling good about the performance of her class, was happy to see her students utilizing prerequisite concepts that their mathematical histories had exposed them to and bringing all the relevant ideas together to solve the problems. Even though it was a topic she liked to "teach," she was happy she had relinquished her autonomy "teaching" and had given the students a chance to do what they did. This they all did with eagerness as no one complained or showed any sign of frustration. Mrs. Sinclair went on to explain: *"Every group came up with something; they weren't just there folding their hands and saying, I can't. They all tried to do something."*

Mrs. Sinclair further explained that, under normal teaching conditions, teaching the solution to these equations using the various methods would have taken about three or four class sessions; however, students learnt these alternative paths to the solution during only one class session. They were now using one method as a check for the solution of the other. Mrs. Sinclair continued to express her observation about a particular group in which the students disagreed about the working out of a particular problem, but they tried it together the way the young man was suggesting even though they knew it would not have worked out, and then they solved it the way the group had originally suggested. This attitude, we concluded, showed how they were accommodating differences and feeling free to explore each other's ideas. The fear of not arriving at a solution was not the focus; they did not focus on being left behind but took the time and solved it his way. This was an indication that the competitive aspect which used to occur naturally was disappearing from this learning context.

Providing her overall impressions of the lesson, Mrs. Sinclair stated that she was happy with the attitude displayed by her students:

> *The good thing is that they came up with the solutions and they really wanted to try and solve the problems by themselves. And because they solved it and it is something new, they felt very good about themselves. I don't know if every topic will lend itself to that.* (Reflect. Conf. Oct. 16)

From her observation, Mrs. Sinclair also noted: *"In this morning's class they were very willing to explore, to discover, and to investigate; everybody was willing to try."* This setting, she deduced, in reality had *"created a new environment for learning – mentally and socially so that learning could take place."*

Mrs. Sinclair, experiencing her first coaching conferences, initiated her students to the questioning technique and further developed it by having her students "coach" her in the large-class context. From all appearances, this was her first " near perfect" *Mediated Discovery* lesson in which group members invited explorations through probing. Everyone felt good about what was accomplished within this setting. Students were "uncovering" mathematical concepts for themselves without having the teacher telling them. This led to conceptual understanding as no one, including the teacher, was fearful of soliciting help from others. Thus, Mrs. Sinclair's role was changing from that of a dispenser of information to a more facilitatory role. This setting, Mrs. Sinclair concluded, was now creating a new environment for learning.

Utilizing the *Mediatory Discovery Approach* in the student small-group setting, the teacher served only as facilitator; with every student participating, they drew from their mathematical skills and used their previous mathematical knowledge to arrive at the various solution paths to the problem (**Finding # 39**). The setting for the *Mediated*

Discovery Approach with the small-group context created a new social and mental environment for learning, and so students felt good about themselves and were willing to explore, discover, and investigate solution paths to the problems (**Finding # 40**).

Mrs. Sinclair's Continued Use of the MLE

Mrs. Sinclair continued to use the *Mediatory Discovery Approach* to teaching and learning in her classes. Occasionally, she reverted to direct teaching by having students working individually; but had to re-teach or to allow the students to derive the solutions for themselves. With students having mastered the solution of pairs of simultaneous equations by various methods, Mrs. Sinclair introduced her students to the solution of simultaneous word problems. Utilizing the techniques involved in *Reciprocal Mathematics Teaching*, Mrs. Sinclair in the whole-class setting used direct teaching to solve a word problem incorporating the questioning technique as the students would in the small-group activity. After this example was done in the large class setting, she assigned the problems to the students so that the solution process she engaged them in could be reciprocated in the small-group setting.

An example of a small group activity. For one small-group activity the group-teacher read the problem: *"A girl bought two roties and three fries for $10. If she bought five roties and two fries she would have paid $19.50. Calculate the cost of each roty and the cost of each fries."*

Questioner: *What is our objective?*
Group-teacher: *To find the cost per roty and the cost per fries.*
Questioner: *How are we going to solve it?*
Group-teacher: *By forming two simultaneous equations. Equation one is equal to* $2x + 2y = 10$ *and* $5x + 2y = 19$. *We are going to eliminate x so we multiply . . .*
Student: *It is $19.50*
Group-teacher: *So we multiply equation one by two and equation two by three. Our result*
is $4x + 6y = 20$
minus $\underline{15x + 6y = 58.5}$
negative $11x + 0 = -38.5$; $x = 3.50$. *So the cost of . . .*

Chorus: *one roty is $3:50.*

Group-teacher: *We are going to go back to equation one and we are going to say. . . we are going to substitute $3:50 for x and we are going to say two times 3.50 plus 3y = 10. Our result is 7 + 3y = 10. Minus 7 from both sides so y = 1.*
Student: *So one fries costs $1.00*
Chorus: *So the cost of one fries is $1.00.*

Students continued to solve the problems through thinking aloud and recording the steps they were taking to arrive at solutions during their group problem-solving activity. As they continued to solve the problems they reciprocated their roles with a different person becoming the teacher during the solution of each problem. By following the same format each time to arrive at a solution, students seemed to assume a routine way of solving the problems. Each time the group-teacher would read the problem, and then the questioner would ask: *What is our objective?* with the other members of the group responding, and then asking the follow-up question: "*How are we going to go about it?* After which the teacher would launched off in her explanation until the solution is arrived at. At times, they all would be working together, thinking aloud, questioning each other, and making suggestions.

Mrs. Sinclair continued to use the new approaches in her classes for the various topics that she taught. At the beginning of the term, Mrs. Sinclair started her 4-General class with the solutions to simple equations, leading to the solutions to simultaneous equations, and then to the solutions to quadratics. Mrs. Sinclair was able to provide Mrs. Jacobson—her coaching partner—with an initiation to the *mathematics learning experiences* based on her own experiences utilizing the new approach. Those principles which she mastered as a result of being coached she mediated.

Visiting Mrs. Sinclair's class on December 4, I inquired about the concepts she planned to have the students learn for that particular class. The students were doing a test for the first 30 minutes and then they would be introduced to quadratics. Mrs. Sinclair used the same approach that she used for her "perfect" *Mediated Discovery* class. Students were given the quadratic expression $8x^2 + 10x + 3$ to factorize. At first, most groups were unable to come up with a solution; however, within the 35 minute class-period, one young man was able to solve it with his group members. He shared the solution with the help of his group members in the large class-setting. Within the same class period, and from the explanation given, students were able to solve the problem for themselves within their groups and write a detailed solution process to the given problem even though the teacher had told them they could try it for their homework problem. (See **Appendix H** for a sample of Students' work). Students' *Discourses* within their groups impacted on their written work as they provided detailed explanations as part of the solutions to given problems

CASE III

MR. LENNOX AND HIS CLASSES

Mr. Lennox's Initial Experience in Generating the MLE with His Assigned Classes

From the shared experiences of the September 22 meeting, Mr. Lennox maintained that because of "*the teaching atmosphere in the classroom,*" coaching seemed to be "*an invaluable approach but what we are concerned with is finishing the syllabus.*" Finishing or "covering" the syllabus was Mr. Lennox's major concern. Comparing his own experiences as a student with his teachers' wanting to cover the syllabus and his present attitude, Mr. Lennox admitted: "*I think that was being used by myself also, but the coaching experience has really altered that, and I am listening to the students more. The time-waiting aspect . . . I am always conscious of that now after I have asked a question.*"

Mr. Lennox's consciousness had been raised concerning the employment of the non-judgmental verbal and non-verbal approaches to effective teaching; as a result, his anxiety about finishing the syllabus had been altered. The use of these *tools*, he admitted, was becoming a part of his approach to teaching and learning. He claimed to be listening to his students more and allowing them time to think through their responses. Mr. Lennox further stated that the students "*are responding more*" and "*I am using their ideas to come up with what I want to bring across to them, so they feel satisfied.*" Hence, allowing students to voice their ideas and being attentive to what they said, Mr. Lennox was using their ideas while teaching; as a result, students were feeling satisfied and were showing interest in wanting to share their ideas more. Mr. Lennox went on to mention: "*Prior to this experience, I wouldn't have paid much attention, but now knowing . . . about the paraphrasing and the intonation, these things I do emphasize*." Silence and wait time as well as other *tools such as* paraphrasing and intonation were now being incorporated in the classroom discourses as a part of everyday teaching.

Learning of the successes and the difficulties that the other teachers were experiencing with grouping, Mr. Lennox shared the following with the group of teachers:

> *I have just implemented mine on Friday; I am meeting them tomorrow and the coaching strategies will be used again, but they are going to change roles. Whoever was the teacher before will become the recorder, and the recorder will become the coach, so I will alternate the roles within the same group.*" (Sept. 22)

Mr. Lennox had started to introduce the roles to his Grade 10 class. Drawing from Mrs. Scott's experience, he suggested to the other teachers that "*that is something that you could use*." Drawing from the experiences of others and having implemented student-grouping in one of his classes already, Mr. Lennox anticipated gains in his classes as a result of student-grouping. He noted:

> *I have gained some knowledge from this experience. Knowledge as to how better we can put things in place for the whole teaching and learning situation. . . I must confess that in the implementation, what I have seen based on the responses of the students is really welcoming, and expressions such as "I was able to better understand" and "My confidence grew" are telling me that this experience is doing something to the learning of mathematics.* (Sept. 22)

Even at this early stage the students' responses to the initiation of this new experience were telling a story, that Mr. Lennox perceived as welcoming. It said that something was happening in respect to enhanced learning of mathematics on the students' part. Mr. Lennox concluded:

> *It is a good method of teaching.* [And as for the students] *their confidence level has risen to the point wherein they are not afraid to really go at a problem. So maybe in the future based on the coaching experience and with the knowledge that we are trying to get across, we might be saying that coaching is going to take away the fear of mathematics; that is the better way to go, and this might be the method.*" (Sept. 22)

Embarking on the translation of his PDP experiences which he claimed had raised his consciousness and made him aware as to how to put things in place for the teaching and learning context, Mr. Lennox had begun to employ the nonjudgmental verbal and non-verbal *tools* for effective teaching and learning, and as a result students' responses were positive as students revealed no fear to try and solve mathematics problems **(Finding # 41)**

Creating a Climate for Alternate Approaches in Mr. Lennox's Classes

With the decision for me to observe each teacher's class while waiting on the new timetable, I visited Mr. Lennox's Grade 10 class on Friday, Sept 26. Mr. Lennox grouped the students in groups of three. Students knew their assigned roles. Each one called upon was able to explain his or her role in the group to the other members of the class.

For one group, I observed that the "group-teacher" was able to interpret the problem given and explain step-by-step the solution path. However, other group members proceeded to look on the worked example and copy the solution. As I continued to observe, I made suggestions for each student within the groups to solve the problems for himself or herself. As they proceeded to do so, I observed that they were now identifying gaps in their understanding of the particular solution path for the problem. As they came upon gaps in their understanding, they started to ask questions instead of looking at the worked example.

On Sept. 29, I visited Mr. Lennox's Grade 8 class (38 students were in this class). This was the first time they were being initiated into group roles. Like those in the Grade 10 group, each student was assigned a role in groups of three. He explained each role and gave suggestions for possible questions that could be asked by the questioner and how each group member might go about executing his or her role. This was similar to how Mrs. Sinclair had introduced her students to the roles. However, Mr. Lennox did not engage the students in any role-playing. He questioned a number of students about the particular role they were assigned. Students displayed understanding of their roles and could explain each to the rest of the class. The roles assigned were "coach," "teacher," and "recorder." While students knew their roles, they had not yet been given the opportunity to practice them in their groups.

Because he had been assigned this particular class after the beginning of the school term and had not taught at this level for many years, Mr. Lennox decided that he would like to be coached to use the *mathematics learning experiences* for this particular class. He also decided that he would be using a general problem-solving activity to introduce his teaching to the group. Initially, Mr. Lennox wanted the whole class to work together with him in solving the problem. After finding out how he was going to approach it, I suggested that, instead of solving the problem in the whole class-setting, he could give the students the problem and allow them to come up with solutions in their small groups. He conceded to my suggestion, limiting the time they should take to do this to 10 minutes. Therefore, for an initiation into their roles to work together as a team, Mr. Lennox decided to give them the general problem and allow them to solve it in their groups. The problem he gave was: "*Suppose you were given an 8 liter and a 3 liter pail without any markings* [graduations] *on them. How could you use the 3 liter pail to pour exactly 4 liters of water in the 8 liter pail?*

Some groups came up with various approaches to the solution within the time assigned. However, Mr. Lennox was judgmental in his remarks concerning the solution to the problem as he told the class that one group did well but the others did not impress him. Referring to the solution provided by the group, he said: "*I never thought of it this way but this group over here gave me a good idea.*" He called on the particular group to share their solution. After this sharing, the class clapped, but no other groups shared their solution. He proceeded to use direct teaching to teach the particular concepts he had planned for that lesson. Students were not given time during the class to solve any problems but were given them for homework.

After the class, Mr. Lennox reflected on his acceptance of only one mode of solution for the problem given to the students. He concluded that he was judgmental in his approach in soliciting the responses. He also stated that he believed that he had set up the class to believe that that was the particular solution he was looking for. He further stated that during the class he never thought of his reaction as being judgmental, but the reflecting process raised his consciousness to the issue. Mediating on how he might have approached this differently, we explored alternatives. One alternative that was key to the MLE was based on his observation of the various solution paths taken by the students. Three or four groups that were very different in their approaches could have been asked to explain their solutions in the large group-setting. Student would then be able to deduce the logical arguments and conclude for themselves the possible solutions. Mr. Lennox decided that he would employ this suggestion during his next class.

During the next class on Tuesday, September 30, Mr. Lennox also used another problem-solving activity to empower the students in their roles within the groups. The group-teacher in each group read the problem: "*Two men and two boys went to cross a river; none of them could swim. They had only one canoe and they all can paddle. The canoe will hold only one man or two boys at any one time. How will they cross the river?"* In one small-group, after the problem was read, the coach solicited suggestions from the other group members and then offered her suggestion to initiate the problem-solving process.

Coach: *Any suggestion? You have any? Ok. I suggest that one man and one boy travel across the river, and drops off the boy and the man travels back and picks up the other boy. And the man comes out and the boy travels back and picks up the other man and the two of them go across and then all of them reach across the river.*
Recorder: *But you see, the problem with that is that it said only one man or two boys can hold in it. So how come one man would carry across a boy or a boy would carry across a man? Tell me how that would happen now.*
Coach: *Oh I see your point, I see your point. I was thinking something else.*
Recorder: *Teacher, do you have anything to suggest?*
Coach: *Teacher, would you like to suggest anything?*
Group-teacher: *Ok. Two of the boys could go over the river. Right?*
Recorder: *Wait, I have a suggestion. I think two boys, you see could tie a rope to the canoe and the two boys will paddle across. The two boys will come out and the two men will pull back the canoe and one man now will go across come out and then the other man on the other side of the river will pull it back and paddle across by himself.*
Coach: *But you can't do that . . . because guess what? You don't know how wide the river is (laughs), and you don't know if they have a rope long enough to match the width of the river, and they have to measure the rope before they put it on the canoe.*
Recorder: *Let us estimate this . . .*
Coach: *Teacher what would you like to suggest? You haven't suggested anything yet.*
Group-teacher: *Well maybe both of the boys could go over in the canoe. Right? One of the boys would come back and (I don't know).*

Recorder: *I think mine will be correct, but you said just now only one man or two boys could hold in it, so mine is the correct one. So the solution to the problem is . . . Two boys will have to paddle across and let off one boy, no, and the two boys will come out with the two men pulling in the canoe with the rope. And I assure you it is a strong rope. Two men will pull it across; one man will paddle back and the other man would paddle himself across.*

Coach: *I think that is the best solution . . . But you don't know if they have a rope or how wide the river is, or if they have a rope long enough.*

Recorder: *Let's say . . . .*

Coach: *Ok let us read the question and see if we can solve the problem. Listen to the question: Two men and two boys want to cross a river. None of them can swim. They have only one canoe and they all can paddle. The canoe would hold one man or two boys at any one time. How will they cross the river? Think about it now girls . . . I still think my solution is best.*

Recorder: *Think about the question. Think if there is any other solution. Teacher, what would you suggest?*

Group-teacher: *I think . . . .*

Mr. Lennox, the class teacher, came by this group, inquired how they were getting on; the recorder explained one of the suggested solutions. He listened and then asked: "*Did you make a record of it?*" and then moved on to other groups.

Coach: *So you see my suggestion is possible. Maybe be sir will let me talk it out.*

Recorder: *and mine is possible too. And maybe we are both right.*

Coach: *Teacher, you did not suggest anything.*

Group-teacher: *Of course I suggested.*

Coach: *It was the coach and the recorder who suggested.*

Group-teacher: *My suggestion*

Recorder: *Teacher you did not suggest anything. It was only the coach and the recorder who suggested anything. And we said they were both possible.*

Group-teacher: *My suggestion was that what I had in mind the coach said it. How could I say that again?*

Coach: *You could still have said it.*

Recorder: *Maybe it is something different.*

At this moment Mr. Lennox sought their attention for the whole class sharing session. The group-teacher continued to offer her suggestion.

Group-teacher: *Two little boys, there were four of them, two big men and two little boys. The two boys went over first, and left one of them over there. One of the boys came over and came out and gave one of the big men. The big man went over and gave the other little boy and the little boy came over back and came out and gave the other big man. The big man came out no, the big man went in the boat and went over, and the other little boy who was over on that end came over. Then he picked up the other little boy and both of them went over.*

Mr. Lennox asked the students to share their group's solution(s) in the whole-class setting. He followed through with the suggestion of trying to eliminate value judgments by soliciting various responses from the various groups, whether they were similar or dissimilar. Students felt confident in expressing how they solved the particular problem. Students approached the problem using varied and unique solution paths which were generated in the small-group setting. The class, as a whole, was exposed to possible solution paths approached by the various groups, and together they explored them to identify the ones that were feasible.

Students, while were working in their groups, sought to empower each other by ensuring that each person made a suggestion or gave an input toward the solution. Reflecting on this problem-solving activity, Mr. Lennox agreed that the particular grouping was "*a way of empowering the students; their confidence level peaked.*"

Mr. Lennox's First Formal Cognitive Coaching Experience

Mr. Lennox decided that he would concentrate on his Grade 8 class for the use of the MLE. After observing two lessons with the introduction and execution of the roles in the student small-groups while solving the general mathematical problems, I asked him if he would like me to coach him in accommodating the grouping techniques used in this setting for the teaching and learning of other mathematics content. My reason for asking was based on my perception that having had the opportunity to undertake individual translation and being initiated into the accommodation of certain techniques for the general problem solving activities, Mr. Lennox was now ready to make a step in the direction for other mathematics learning activities. I also asked because he did not initiate the move in this direction and because the school term was slipping by quickly and the essential techniques for the development of conceptual understanding embedded in the MLE had not yet emerged for him. For the week of September 29, I invited Mr. Lennox and Mrs. Scott to allow the groups to try to come up with ideas for the solution to problems before they told the students how to solve them.

The planning conference. The arrangement of the new time-table did not make it possible for another teacher to coach Mr. Lennox for the full coaching cycle. Therefore, after school on September 30, Mr. Lennox and I had our first formal planning conference for his Grade 8 class to be taught on Wednesday, October 1. The planning conference map (Costa & Garmston, 1994, p. 18) was utilized to map out the territory of this first planning conference and subsequent ones. The usual clarification of objectives was sought, along with the anticipated strategies which would be employed for the achievement of the specific objectives for the topic on bases.

During this planning conference, I planned to videotape Mr. Lennox's lesson so that he could watch what transpired during the lesson before we did the reflecting conference. He also planned to give a pre-test for the unit he was about to teach. For the *mathematics learning experiences*, special attention would continue to be given to the key issues which had been observed during the previous lessons, for example the timing of the various group activities, the noise-level, and the non-use of judgmental verbal and non-verbal expressions. One key objective that I mediated during our planning session was for Mr. Lennox to help each student to develop his or her mathematical power. If students are allowed to be engaged in their own learning, they can learn any concept. Therefore, activities that would generate maximum participation on the part of all were incorporated into the lesson. Mr. Lennox continued to expand this by stating that he would continue to allow the students to work in their groups, and then

> *If they are not getting it I will tell them, but I will wait to actually get it from them. What I have discovered is that when they themselves get it instead of me telling them they remember more because it is from their experience.* (Plan. Conf. Sept. 30)

I went on to explain to Mr. Lennox that

> *One of the premises on which this* (MLE) *was being built was that whenever the kids work together in groups even though they are working and sharing in the group, the kind of work that is being done in the group-setting some time at a later date on their own, they will be able to do the same level of work or a better standard of work than what they did together as a group (Vygotsky, 1978).* (Plan. Conf. Sept. 30)

Mr. Lennox proceeded to share his ideas on how the lesson would be executed and the sequencing of activities. I mediated for the missing links (Plan. Conf. Sept. 30). We had decided that within the large group-setting the teacher would review the lesson content dealing with prerequisites. Then students would work in small groups, and finally they would share their ideas in the large group session.

Reflecting on this planning session, Mr. Lennox admitted:

> *It raised my consciousness in the sense that a number of things that I didn't think about I was now made conscious of. It also propels you to be flexible. For example, when you asked how would I ensure that each student in the group understand, initially, I thought of only two things but after being probed, a third came to mind. It also brings a level of confidence; as I think of all the possible things that might happen, I am prepared for them; so it brings a level of confidence. Also, setting out the activities and the time-frame attached to them, I will be better able to control my time.* (Planning Conf. Sept 30)

Reflecting on his engagement in the planning conference discourse, Mr. Lennox agreed he was allowed to mentally rehearse what he had planned; his consciousness was raised to the possible things that might occur in the particular situation, and this awareness generated a level of confidence in him and encouraged flexibility on his part **(Finding # 42)**.

The lesson observation. During the lesson observation on Wednesday, October 1, I was completely caught off guard by the first activity. The pretest given was on percentage. Therefore, I thought that Mr. Lennox had changed the topic he had planned to teach, and so I did not video-tape the lesson. However, after the pretest, he asked the students to get into their groups. He gave each group a card with a set of problems and asked them to convert 69_{10} to base five and 21_{10} to base two. In the initial stages of the group activity, the noise level was high, but Mr. Lennox employed the techniques we had discussed during the planning session, and for the remaining portion of the class, the students were no longer talking loudly. The students came up with the correct solutions, which they shared in the large class setting; for example, for 69, the solution was 234_5, and for 21, the solution was 10101_2 but when asked to read the solution for 21, they read it using base ten place value system. When questioned about the value of the numeral in the 5th place, students said "10 thousand." The teacher counted the digits: "1, 2, 3, 4, 5," which he reaffirmed valued 21 and questioned whether the students were still saying 10101_2 was equivalent to 10 thousand plus. Some students still said "yes" confidently. Mr. Lennox continued to use the place value chart for base ten to lead the students to examine the value of what 10101 would mean in base ten. He also continued to use direct teaching to show the place value of each digit of base five. One of the planned student-activities was assigned as homework because the class-period had expired. For bases 2, 3, and 8, they were asked to write the place value of four digits.

The reflecting conference. During the reflecting session with Mrs. Scott and me on Thursday, October 2, Mr. Lennox recalled the events of the class. He noted the reduction in the noise level after he made certain observations to the class. He also noted that those students who had been speaking loudly lowered their voices after he used the technique with them.

Mr. Lennox also noted the misconceptions the students displayed in reference to the task they were asked to complete in their groups. He noted that his objective was to find out what the students knew about bases. He deduced that students were not aware of the meaning of the place value of bases. Also, because they had learnt previously to convert numerals from base ten to any base but had not done the reverse, they used the base ten place value concept to interpret the place value of the other bases. All groups solved the problems in the same manner.

He observed that, because of the planning conference, he *"was open for anything:"*

> *I've observed that the pre-conference really prepared me for the unexpected; so what came out today in the class if I had not gone through that pre-conference, I would have been shocked. But the Pre-conference had already raised my level of consciousness so it did not come as a shock. As a result, I was able to deal with their responses better . . . because the pre-conferencing impelled me to be flexibility.* (Reflecting Conf., Oct. 2)

Even though he was surprised by the students' responses, he was able "to think on his feet." Mr. Lennox maintained that he was *"learning not to be judgmental."* He also stated that he was developing

> *a level of tolerance to really appreciate their ignorance and to know it was ok for them to be wrong. Here again, I think it is the whole pre-conferencing and the fact that you have to be thinking of alternatives.* (Reflecting Conf., Oct. 2)

Looking back at the group activities, Mr. Lennox noted:

> *The group-approach is really working because it gives each student an opportunity to contribute. It was quite noticeable that once one member said "Alright I am going to the board," that member was really providing a representative view of the group and if the member made a mistake the other members of the group were willing to point out and say that that was not what we were saying. It tells me that there is a lot of learning taking place, and even in terms of respect for one another's opinion, that is already coming out.* (Reflecting Conf., Oct. 2)

Mr. Lennox continued to recall that the misconception was so widespread that he believed that, if the students were not working in the particular group-format but were working individually, they would have felt uneasy about the ideas shared. The misconceptions students displayed were discussed and suggestions were made to help them to overcome them during the next class.

During the reflecting conference discourse, Mr. Lennox reinforced that the pre-conference discourse prepared him for the unexpected, as it had already raised his consciousness about the various possibilities that might occur because he always had to be thinking of alternatives, and as a result he was impelled to be flexible and was able to think on his feet and to deal with the turn of events, because he was developing a level of tolerance and learning not to be judgmental (**Finding # 43**).

Mr. Lennox's Continued Exploration with MLE

The homework activity, for students to write out four place values in exponential and word form for bases 2, 3, and 8, was used as the starting point for the lesson for Tuesday October 7. It was suggested on Monday, October 6, when Mr. Lennox shared his plans that, since students had worked on the homework problems individually, they should get into their groups at the beginning of the class and share their ideas. Then a representative from the various groups with similar and dissimilar responses should share for the first few minutes in the large-class setting. So, for the first activity, students worked in their groups and then shared their ideas in the large class-setting, recording their solutions on the chalkboard. They were able to do this correctly, putting the place value names for each digit. They showed that $2^{3\text{ meant eights}}$, $2^{2\text{—meant fours}}$, $2^{1\text{meant twos}}$, and 2^0

meant ones. They did the same for the other assigned bases. The planned activity that should have followed after this—students in their groups would be asked to write a numeral in base two or one of the other bases and then come up with the value in base ten—was not assigned to the students. Instead, Mr. Lennox reverted to direct teaching.

There were several opportunities for students to derive certain concepts for themselves during the class period, but Mr. Lennox did not capitalize on the opportunities. In the setting, students worked individually within their assigned groups but did not utilize the roles. Neither was the utilization of the roles encouraged by the teacher. During the reflecting session, Mr. Lennox was asked why he did not include the planned activity that should have followed after the students in their groups had come up with the meaning of the place value for the given bases. He stated that, because it was a Grade 8 class, students might not have been able to handle that. However, he was reminded that the same students in a previous classes had derived the solutions to other problems.

At the various stages of this program, how the program was going to be maintained was always taken into consideration. I did not want the teachers to be too dependent on me at any stage; hence, I tried to have another teacher coach Mr. Lennox. However, as a result of the new time table, it was difficult to have a reciprocal coaching dyad between Mr. Lennox and Mrs. Scott. However, on Tuesday, October 14, the next planning conference was scheduled; and, since Mrs. Scott also had to teach a Grade 8 class, this session served as a planning session for both teachers as they shared their ideas and techniques. With Mrs. Scott as coach and me as co-coach, we mediated for specificity and alternative strategies for what Mr. Lennox had planned to teach. It was also decided that she would observe Mr. Lennox's class for the first period of the double-period class the next day because she was scheduled for another class after the first period of Mr. Lennox's class, and I had a another meeting.

Mr. Lennox was still doing direct teaching during most of his lessons, so suggestions for the MLE were made for the students' activities during the planning session on Tuesday, October 14. Mr. Lennox planned to have groups, but to have the roles defined with emphasis placed on each role. The recorder should show how the group members solved each problem. Emphasis was also placed on the teacher, who should provide explanations and suggestions. Mr. Lennox planned the group activities, timing each activity and clearly outlining what he wanted groups to be doing during each activity.

The activities planned for the first period did not take place as Mr. Lennox engaged the students while doing direct teaching. But before Mrs. Scott took her leave at the end of the first period to go to her class, she made a judgmental remark to Mr. Lennox. She stated that Mr. Lennox had done an excellent job of teaching, but what students really needed was to be engaged in their own learning within the groups. Mrs. Scott did not withhold her comments until the reflecting session, and this seemed to cause Mr. Lennox to withdraw from subsequent sessions when she would have coached him.

The Reflection and a Turn of Events

As I invited Mr. Lennox to summarize his impressions of the lesson, he was free to communicate what was important to him. He had incorporated the group activity towards the end of this particular lesson; his reply was:

> *Surprisingly what I picked up was that some persons in the group did not understand what they were supposed to. But working in the group, you had at least one person in the group who had done it so they explained to one another. Those who understood were able to explain and help those who did not understand. Just by sharing the ideas and by having a number of students saying how they arrived at the answer, the others understood* (Reflecting Conf. October 16)

For this particular activity Mr. Lennox had the students sit in their groups, work individually, and then share their solutions. Examining what transpired during the lesson, I introduced another aspect of MLE to Mr. Lennox that I thought would reinforce the significance of the group activity as it was introduced in the initial stages. I explained:

> *Another thing we probably have to look at is to put the onus on the students for the correctness of their work. Whereas it is the teacher that they look to mostly for verifying whether or not what they do is done correctly or incorrectly, you want to put the onus on them now. So within their groups they do the problems and check each other's work. . . . Also the questioner should ask, "How did you get that?" or "Why is this different?" "Why did you do it that way?" "How did you get that*

> *number?" So if they noted an error or something different in another group-member's work, a question is posed for the particular error spotted. So you will be putting the onus on those within the group. You are empowering them to ask questions so that when you look on, you will just be doing further facilitation.* (Reflecting Conf. Oct. 16)

Mr. Lennox never showed up for subsequent planning sessions with Mrs. Scott. He always made excuses about having other things to attend to. His visits to the mathematics room, where he used to come in before and after each of his classes, seemed less frequent. Also, the scheduled mid-term exams and the mid-term break seemed to have kept him away. For the October 22 professional development session, it seemed as if he would not show up, and so he had to be sought after. The coaching dyad between Mr. Lennox and Mrs. Scott was not reciprocated, but a reverse coaching dyad emerged as Mrs. Scott sought to have Mr. Lennox coach her while she served as coach for one of the new teachers who expressed interest in being coached for his class also.

Due to political reasons in the school, the teachers decided to remove MLP officially from all classes in lower school, Grades 7 to 9. This included Mr. Lennox's Grade 8 class. Since Mr. Lennox and Mrs. Jacobson could no longer officially use the MLE in their classes in lower school, Mrs. Jacobson requested that she be coached by Mr. Lennox for her Grade 11 mathematics class because the coaching dyad between Mrs. Jacobson and Mrs. Sinclair had been disrupted, and so a reciprocated coaching dyad was generated between Mr. Lennox and Mrs. Jacobson (November 18). Mrs. Jacobson coached Mr. Lennox for his Grade 11 class while Mr. Lennox coached her for her Grade 11 mathematics class. Meeting in the mathematics room on a regular basis, I continued to offer suggestions to Mr. Lennox and the other teachers for their classes as I continued to sit in on the coaching sessions, playing a minimal role as co-coach.

With the surfacing of this political problem, Mr. Lennox's Grade 8 class was officially removed from the Mathematics Learning Program (MLP). As a result, data collection from this group was discontinued. Mrs. Scott, as Department Head, at the end of the school term insisted that I elicit the students' impressions of the aspects of the MLE that they were exposed to since that was a part of my original plan. Therefore, on December 4, I went with Mr. Lennox to his Grade 8 class and video-taped the exiting interview session conducted by Mr. Lennox, the class teacher. Mr. Lennox told the students to feel free to express how the experiences in their mathematics classes had influenced their learning. I was surprised with the students' reaction, as I was not aware that Mr. Lennox had unofficially continued to expose this group of students to the MLE.

Mr. Lennox seemed to be timid to release the students totally to think for themselves although he provided them with "windows" of opportunities and saw that this alternative approach empowered students in their roles, enhanced their confidence level, gave students the opportunity to contribute and to share ideas with one another, working together as a group, respecting one another's opinion, encouraging one another to make suggestions for solution of problems, and ensuring that each understood the concepts to be learnt (**Finding # 44**).

Mrs. Sinclair's and Mr. Lennox's Students' Impressions to their MLE Experiences

Mrs. Sinclair's Students' Reaction to Their MLE

Mrs. Scott's students, having had their first "perfect" Mediated Discovery class, were just as elated about the work they had been able to do in their groups as the teacher. Their impressions were solicited in writing in response to the question eliciting their impressions about their experiences in their groups: *"What did you like or did not like about your group activity?"* According to Student 8GA (Oct.16):

> *My group helped me understand the problem more. It made me more comfortable to be wrong about something and correct it. It made me feel confident especially when they asked me what I think they should do. Working in the group helps, in that, I think I like math more and understood the problems better. You feel comfortable working in a friendly environment and more relaxed, making you want to work. I also liked the way my group worked fast and yet very thoroughly. They were friendly and understanding even when members did not understand.*

Like many other students, Student 8GA expressed how the setting brought about by the *mathematics learning experiences* (MLE) made them feel relaxed and even comfortable to be wrong about expressing their ideas. Working with their peers, students were aided in creating the necessary climate for mathematics learning to take place.

Student 26GA also reinforced this when she stated: *"Because we are of the same age-group, it feels more comfortable to talk and reason with one another."* A comfortable atmosphere was generated in the setting *"because if I did not understand a problem, I could always ask a member of the group to explain what he or she did to get the answer."* Also, the reciprocal nature of the setting that involved the questioning and explaining lent itself to students' feeling appreciated. Student 26GA noted: *"I like the idea of working together and helping each other."* Also, Student 15GA stated that he liked *"the group activity because working in the group made us to be more self-confident and we learn from each other."*

The kinds of questions students were invited to ask within their groups took on a stereotypical nature at first, as mentioned previously. Student 17GA reported that for him, *"At first, it was a 'circumlocution thing;' it was a round about expression thing. I did not like it at first, but then it became like a daily routine. I understood the questions clearer and learned from them in a different way."* Now, he believed that questioning that way allowed *"each one to express his or her views about the problems and helped us to understand better." Student* 13GA, along with several others, reinforced 17GA's statement: *"We pooled our ideas in solving the problems,"* while 6GA elaborated:

> *I learn from the other members of my group in a very interesting way. I learn more and I feel more comfortable. They explain things to me that I did not understand and each one shares his or her own opinion and methods towards the working of the problems.* (Student Reflection, Oct. 16)

According to Student 14GA, *"I also loved the attitude displayed because no one turned their minds away from the problems." Student* 23GA provided a further elaboration, *"Because whenever I made a mistake one of my group members was always there to see it and make me correct it"* (23GA). Also, the sharing and caring expressed by most students was echoed by 2GA who noted: *"We shared ideas and we made sure each member understood what was to be done, and we asked questions"* so as *"to make the foggy part clearer"* (16GA). *"My group members ensured that you understand before they proceed"* (16GA). As well, 5GA wrote: *"If I don't understand I can ask why, how, etc."*.

For Student 21GA, his success in understanding the solutions paths of the equations could be attributed to the group because it

> *helped me to work carefully and go step by step. The group also helped me because I learn from the others different ways of solving the equations so that in an examination if I do not remember one way of solving an equation I can use another.*

For Student 7GA, the fear triggered by the announcement of the topic dissipated as a result of working with her group. She stated: "*When I first heard about 'simultaneous equations' I thought it was very difficult, but in group-working, I love the problems.*" For Student 24 GA, providing explanations triggered recall of concepts previously learnt and a clearer understanding of the concepts under consideration: "*Even when you are explaining something to someone, you are actually recalling what you have learnt and understanding it better*" (24GA). Student 15GA's group made allowance for the diversity of opinion and the exploration of diverse opinion within the group. This approach influenced his understanding:

> *The group affected my success in understanding, in that we disagreed about the working out a particular problem and in the end we had to do over the problem. Because we had gone over the problem we had agreed, and the problem was solved.*

Being exposed to and being involved in the MLE almost in its fullness, students were helped to comprehend what it was that they were asked to solve. They felt comfortable being wrong, as the atmosphere was created where no one 'put them down' as they voiced their ideas. The friendly climate in which they worked helped them to be confident to ask any question as they enjoyed the idea of working with and helping each other. This setting generated a caring climate in which each one ensured that the other understood that which was explained.

Even though some found (and from all observations it was so) the questioning to be mechanical and seemed to be "going around and coming around," in the long run it made sense and students found that it helped them to understand the problems more clearly. That is, they were able to identify the information embedded in the problems and what they needed to find out. The questioning also gave them the opportunity to express their views and to ask other questions. It helped to bridge the gaps in their thinking and set the pace for the generation of alternative ways to solve problems as they pooled their ideas. It also gave them the opportunity to draw upon what they had learnt previously and, as they shared their ideas, they were made clearer. In this setting, everyone displayed a positive attitude and even the supposed difficulty, as suggested by the topic, was removed.

Mr. Lennox's Students' Reaction to Their MLE

Student 1Sec (Dec.4) expressed the general feeling of the class when she stated that *"As I play the role of the teacher, I learn to be more disciplined and how to co-operate with each other. We have also learnt how to come up with different solutions to solve a problem."* She also went on to state that whenever she does different topics and *"I don't understand, and the other members of the group know, they teach me how. . . . Also, when I come up with a false answer they question me . . . and I know if that answer is correct or if it is an error."* Student 4Sec also reinforced this; he stated: *"Playing the role of a coach, I get a better understanding. . . . We also get a better approach to answer a question,"* and *"I understand that I can have many different ways of solving the problem."*

Playing the roles in the groups not only aided in developing alternative solutions for a particular problem but aided in helping each student to co-operate and help each other. Student 5Sec also added: *"I have played the roles of the recorder, teacher, and coach. These roles helped me to understand the work better, and to get the students' views and opinions, and I get the respect of my peers, also." "We also got to know and understand each other better"* (2Sec). According to Student 6Sec, *"Whenever we work in groups, we get a better understanding of mathematics"* and not only that but also *"We get to relate to each other better . . . and find solutions to problems with our friends."*

An added dimension was: *"We all listened to each other, and we all combined our views,"* (7Sec) *"and we are more helpful to each other. If we have a problem, everybody can share ideas until we get the answer"*(10Sec). Also, because the students had been exposed to alternative solution paths for problems within the groups:

"Whenever you are doing a test and time is running out, you can come up with the quickest way possible" to solve the particular problems (10Sec). Not only that but *"I am more open-minded now to solving a problem"* (14Sec); *"I can attack anything I get now"* (16Sec) because

> *When I get a mathematics problem how I worked it out might not be how the other person worked it out, but whenever we pool our ideas on the topic I get to realize that we were all right.* (13Sec)

Reflecting on her attitude before the MLE, Student 1Sec stated that *"I used to hate mathematics. Sometimes when I couldn't come up with an answer I used to cry, . . . but now in the group, the MLP has helped."* She also went on to state: *"When we were not working in groups like this, if I had problems I had to go to evening classes, but now it is not so." "This approach has given me some more confidence in math"* (5Sec). Student 16Sec went on to explain the importance of learning mathematics, because *"Mathematics is in every field of the career you might choose, you will have to have mathematical knowledge."* A further implication of the grouping that Student 1Sec noted was that *"When you are working or studying at higher levels, and if you have to work in groups if you are co-operative you won't have a problem."*

Students stated that their consciousness was raised in many ways in that they learned to be co-operative: sharing with each other, questioning each other to aid each other's understanding, and listening to each other. Thus, they were able to pool their ideas during the MLE and come up with alternative solutions which were helpful even under testing conditions. They also had a choice of solution paths. This group-setting also aided them to be interdependent as they were able to relate to each other because they were working with friends. They stated that the MLE enhanced their attitude toward mathematics because they were now more willing to take risks to solve problems. Students mentioned that working within the groups had long-term implications for functioning well in the work place.

A Summary

Being initiated to questioning in the small groups appeared stereotypical at first but, students were provided with the opportunity in their groups to express their views, to listen to each other and to pool their ideas, to ask why, how, etc. when errors were identified and when clarification was needed to ensure understanding (**Finding # 45**). Explanations in the small groups enhanced understanding of what was being explained; also as ideas were verbalized understanding was enhanced; recall of previously learnt concepts took place and a better understanding of those concepts was also achieved (**Finding # 46**).

Employing the roles in the small groups, students fostered/generated positive attitudes as everyone participated, learned to cooperate with each other, got to know and understand each other, related to and reasoned with each other in a comfortable and friendly environment that made each more self-confident as group members were friendly and understanding even when some did not understand (**Finding # 47**). Employing the roles in small groups, students learned from each other in an interesting way; they were provided with the opportunity to work together and to help each other to work carefully step by step; each was made comfortable to be wrong about anything as mistakes were identified and suggestions for correction were made by group members while solutions to problems were sought (**Finding # 48**). Employing the roles in small groups, students were made more open-minded towards the solution of problems as they solicited and shared their ideas, opinions, and methods, and ensured that each understood before they moved on; thus they learned different solution paths for the same problem (**Finding # 49**). Employing the roles in small groups, students had the opportunity to explore each other's thoughts and to identify whether solution paths were correct or not, although each might suggest a different path, when ideas were pooled each solution was recognized as correct; hence, the various solution paths impacted students' understanding as they learned from each other different ways to solve the same problem (**Finding # 50**).

The implications suggested by students as a result of the employment of roles in small groups were that they have learnt to be more disciplined, they can now attempt the solution to any problem, and during a test if time were running out they could use the shortest method or if they forgot a particular solution path they might be able to recall another to solve a given problem (**Finding # 51**). The employment of roles in small groups have impacted negative feelings and difficulties experienced when working alone, and has long term implications for learning to work collaboratively in the workplace and at higher institutions of learning (**Finding # 52**).

CASE IV

MRS. JACOBSON AND HER CLASSES

Mrs. Jacobson, a lady of very few words, would speak usually only when questions were directed to her. Even then her words would be few. She was a Language Arts teacher, but had been asked to teach mathematics. She had attended only the first day of the June seminars and as a result missed the experiences in which most of the *tools* were employed. The meeting of September 22 revealed that Mrs. Jacobson seemed not to have adopted or adapted any of the techniques for use in her teaching. When questioned about how the teachers felt about the seminar series, her response was "*It was fairly good, I found it informative*." As I probed for the reason that she thought it was informative, she replied: "*The coaching experience, I found it informative*." With a further probe concerning the aspect that made it informative, she responded with laughter: "*In terms of preparation, I prepare more*." Mrs. Jacobson had, in reality, been exposed only to the *tool* of conferencing, which was dealt with in the September seminars; this, she stated, had impacted how she prepared her lessons.

Mrs. Jacobson further stated that, in addition to more detailed planning of her lessons, she was experiencing some changes in herself: "*I have gained self-confidence because I prepare more. I am more confident in what I do.*" She explained: "*With the classroom activities, you learn that there is more than one way and method to teach, and some are more effective than others, and you try to change your method.*"

With the scheduling of coaching dyads after the new timetable during the first week of October, additional elements were explored along with the accommodation of the structure of conferencing. The coaching dyad between Mrs. Jacobson and Mrs.

Sinclair was formed, and it was reciprocal. Mrs. Sinclair coached Mrs. Jacobson and vice versa.

Mrs. Jacobson's First Cognitive Coaching Experience

The Planning Conference

Mrs. Sinclair, as coach, and I, as co-coach, led Mrs. Jacobson through her first planning conference on Monday, October 6. Rehearsing her planned lesson, Mrs. Jacobson informed us of the topic, equivalent fractions, and the objectives and activities for the lesson to be taught to one of her Grade 7 classes were elicited. We probed for clarity and specificity and alternatives to the planned activities. Suggestions were also made for student-centered activities which included the use of manipulatives instead of the planned "chalk and talk" approach. Detailed explanations were provided for the alternative suggestions, and I also lent her a textbook that provided further details on the methodology and activities we were suggesting.

The Lesson Observation

Introducing her Grade 7 students to equivalent fractions, Mrs. Jacobson made use of the fraction bars in her lesson. With students sitting in their groups of 5 or 6, she distributed the fraction strips. They were asked to identify fractions on the strips which were equal and to compare all strips. The fraction strips were divided in halves, quarters, eighths, and sixteenths. After students worked on their own while sitting in their groups, Mrs. Jacobson solicited the equivalent fractions that they came up with. However, from the list of equivalent pairs which were given, she did not ask the students to group them or make any other connections between sets of equivalent fractions. She then shifted to her original idea and wrote 4/5 = ?/20 on the chalkboard. When one student offered her explanation of dividing the 20 by the five in order to find the unknown, Mrs. Jacobson did not accept the students' explanation. Another student offered the explanation of multiplying numerator and denominator by the same number to get the equivalent fraction 4/5 x 4/4 = 16/20. This explanation was accepted, and an exercise was assigned. All students used the same method for all the assigned items. The teacher did not use the names of fractions, for example, for ½ she said "one over two." Students mirrored the teacher's language while identifying fractions.

The Reflecting Conference

After the lesson on Tuesday October 7, Mrs. Jacobson offered her observations, impressions, and feelings about what transpired during the lesson. From the observation of her own behavior during the lesson, she suggested what she could have done during particular instances to make the concepts clearer to the students. Mrs. Sinclair offered additional data from her observations, and together we discussed the issues raised. Mrs. Jacobson's rigidity by restricting the number of solution paths students could offer for the given exercise was also observed. She stated that she restricted them because the ways they were offering were not how she wanted them to solve the problem and she did not want the other students to be confused by these other methods. We tried to help her to understand that it was their way of solving the given problems, and their solution paths might aid their conceptual understanding of what she wanted them to learn.

Instances in which she was judgmental were also discussed. The minimal use of mathematical language was also observed during the lesson, and encouragement was offered for using appropriate mathematical language. For example, instead of saying two-fifths she would say "two over five." It was also observed that this particular reflecting session was focused on the teacher's behaviors, but it was pointed out that focusing on her actions was not our intent. Our objective for subsequent lessons was to focus on how learning was taking place with the students.

Reflecting on the coaching process, Mrs. Jacobson stated that she was happy with the suggestion of the use of manipulatives because she never thought of the particular activity, but she was happy for the method that emerged from the coaching. She offered the concepts she would be dealing with for the next class for which she would be coached the following week—ordering fractions.

Attending only one day of the June seminars, Mrs. Jacobson was not exposed to the processes involved in the use of some of the *tools*; however, having been exposed to the tool of conferencing impacted her preparation of lessons (**Finding # 53**).

Mrs. Jacobson's Second Planning Conference to Incorporate the MLE

On Monday October 13, during the planning conference, Mrs. Jacobson, stating her objectives for the lesson, rehearsed her planned lesson as Mrs. Sinclair sought how the objectives would be achieved. Alternatives to the particular activities were sought as Mrs. Jacobson's lesson reflected the direct teaching mode. Mrs. Sinclair, drawing upon her own experiences with the MLE, suggested that, for the initial activity, instead of the class-teacher giving the procedure for arriving at how a set of fractions with unlike denominators could be ordered, the teacher could give the set of fractions to the students and ask them to put them in ascending order, leaving the students to arrange them and seeing what they would come up with.

Mrs. Sinclair further suggested arranging the students into smaller groups of three instead of the groups of five or six she had been exposing students to. Mrs. Jacobson expressed her surprise by responding *"In my little classroom?"* The space in the tiny classroom which housed up to 40 students seated at their individual desks was not perceived by Mrs. Jacobson as one that could allow students to be rearranged comfortably into groups of three. So she queried *"Split them up into so many groups?"* Mrs. Sinclair continued to explain her reason for suggesting groups of three; the kinds of questions she anticipated were also suggested. To enhance her explanation, Mrs. Sinclair suggested that they both should role-play as students: *"We are both students now."* So Mrs. Sinclair asked the questions while Mrs. Jacobson responded to the what, how, and why questions. Having gone through this activity role-playing students, they were overcome by bouts of laughter. (Laugher was a key element in all our sessions. It was ok to laugh for nothing, and it was ok to laugh about everything. Therefore, we laughed about everything and we laughed about nothing).

Mrs. Jacobson's Reflecting Conference

With students still sitting in their groups of 5 and 6 during the lesson, Mrs. Jacobson solicited the meaning of ascending from the students and requested one student to arrange the set of fractions on the chalkboard. Mrs. Sinclair went to her and reminded her to allow everyone to do the problem for themselves, but Mrs. Jacobson did not respond. Mrs. Sinclair went to her a second time and then she said: "*Let me see if he cannot do it.*" After she said this, she told the class that each person should arrange the set of fractions in the specified order while the young man was doing it on the chalkboard. Students worked individually, and then some were chosen to share what they came up with the whole class. Students were able to arrange the fractions in ascending order, so Mrs. Jacobson asked them to arrange the same set of fractions in descending order. This time Mrs. Jacobson stated: "*Now, you are allowed to work with the person beside you if and only if you can't get it out.*" Students conferred with each other.

On Tuesday, October 14, Mrs. Jacobson had her second reflecting conference. Giving her impressions and assessments of the lesson, she stated that she believed the lesson would have been more effective if she had taught it by showing the students how to do an example and then have them practice a set of questions in an exercise. She further stated: "*I like to be behind them to push them.*" On the other hand, from what transpired in the class, Mrs. Sinclair did not share Mrs. Jacobson's thinking although Mrs. Jacobson did not re-group the students. After asking how she measured the effectiveness of the lesson, Mrs. Sinclair shared her observations. Mrs. Sinclair stated that the students were able to solve the given problem within five minutes without the teacher's telling them anything. Observations were made of two students who did not get the concept readily, one of whom Mrs. Sinclair worked with and one of whom the classmates helped.

Mrs. Sinclair went on to explain that students "*used the Socratic method—it* [the solution] *came out of their own experience, what was within them. The concept was developed by the students.*" She further stated: "*I think the highlight of the class was that it was student-centered rather than a teacher-centered class. Some of the students put it* [the solution] *neatly and they understood what they were doing.*" Mrs. Sinclair also observed that students made connections with other concepts as they provided explanations. But Mrs. Jacobson retorted: "*See how few problems they did.*" However, Mrs. Sinclair reassured her that

> *It is not the number of problems they do; they could do a lot of problems just mechanically and have not learnt anything. That is, they didn't really understand what they did. But in this situation any question you asked, they were able to answer.*

When asked if she would deliver the lesson in a similar manner again, Mrs. Jacobson's response was *"When I have a lot of time."* With an additional assignment for Mrs. Jacobson, the scheduled planning time with Mrs. Sinclair was not possible any more. Also, because it was now mid-term, the scheduled mid-term exams and the mid-term break further disrupted the scheduled planning time; however, I coached Mrs. Jacobson until an alternate arrangement was made.

The reflecting conference discourses provided opportunities for Mrs. Jacobson to be aware of and reflect on her rigidity in the teaching and learning context and her unwillingness to release her students to think for themselves (**Finding # 54**).

Mrs. Jacobson's Accommodating the MLE

Entering a new unit on "Sets," I suggested that Mrs. Jacobson give students a pretest. This she did on Tuesday, November 4. We were not able to have another planning conference until Monday, November 10. I coached Mrs. Jacobson for the lesson on "Sets" to be taught the next day, encouraging the formation of groups of three and defining the role of each. During this lesson, she took this advice. Mrs. Sinclair was able to observe the class. However, due to other school-related programs, we were not able to have a reflecting session until the following week Tuesday, November 18. This reflecting time served a dual purpose. It served as the last reflecting session with Mrs. Sinclair and acted as a transition to a new coaching partnership with Mr. Lennox. Therefore, after the reflecting session with Mrs. Sinclair and Mrs. Jacobson (with Mr. Lennox present), Mr. Lennox entered the first planning session with Mrs. Jacobson. Mrs. Scott was also present for both sessions.

Reflecting on her First Attempt at Accommodating the MLE

Mrs. Jacobson explained the roles to the class and wrote them on the chalkboard: "Questioner: asks questions. Recorder: writes the responses and reports to the class. Teacher: reads the problems and explains." Then she asked volunteers within the groups to select the roles they wanted to play. It was observed that students understood their roles and performed them. Mrs. Sinclair noted that within the groups that she observed closely *"there was maximum participation within the groups. Each person was responding to the problem. It wasn't as if two were doing the problem and one was left hanging in the air. Everybody was working."*

Mrs. Jacobson stated that she enjoyed this class because students *"were working together, and they were able to explain and write the intersection and union of sets without the teacher's help."* Mrs. Sinclair verified this and further stated: *"The answers were solicited among themselves, and some groups went to the chalkboard with the same answer, but they explained it in a different way."* From Mrs. Sinclair's observation, she deduced: *"What I saw was that they were transferring that knowledge to other aspects of school-life."* They were applying the mathematical concepts to their everyday experiences and making the connections. She noted that, while one student was explaining to the class, he was asked a question. Because he had to think about the particular question, *"he threw it back to the class"* but ended up answering it. Mrs. Sinclair also cited the example of the student who *"was able to explain without a hitch. He used the example of the clubs to show intersection, so the intersection would represent the person who was in both clubs."*

Mrs. Sinclair continued to voice other observations: *"The students were not afraid to ask questions of their peers, which I think was good, and their peers were not afraid to attempt an answer."* The roles, Mrs. Sinclair observed, helped students ask questions and offer responses within their groups without being fearful. She expressed her uncertainty about an observation: *"I don't know if it is because they are such juniors but they were answering the group-teacher 'Yes, Miss' and 'no Miss.'"* The group members recognized the group-teacher as their "teacher" and so the respect given to the class-teacher was passed on to the group-teachers as well. Laughing, Mrs. Jacobson responded that indeed *"They were playing their roles."*

It is interesting," Mrs. Sinclair noted, *"that they were able to come up with the two concepts although you said the students knew little or nothing about the concepts."* She further stated: *"They did not just go to the chalkboard and write it down; they were* *able to explain it."* Also, although the class teacher did not request the use of Venn Diagrams, the students used them to illustrate the particular sets. This behavior, Mrs. Jacobson acknowledged, meant *"that they had a little previous knowledge."* Mrs. Sinclair observed, not only that *"but I wrote, communicating their solution was very effective; they were able to articulate it step by step,"*

It was also observed that, after the Recorders from some groups came to the chalkboard and wrote their solutions and provided their explanations to the whole class, Mrs. Jacobson did not offer further reinforcements to what the students explained. Mrs. Jacobson's response was that the concepts were there so she did not see the need; however, if she had observed that the students had not grasped the concepts, she would have provided further explanation. To this response, the additional element of the teacher acting as a representative of the larger mathematical community and who would authenticate the mathematical ideas and concepts by accepting and verifying students' solution procedures or by providing elaborations was reinforced. Also, in the whole class situation, if there were areas of mis-interpretation or misunderstanding, the teacher's explanation would probably provide clarity. It was also noted that this was a good opportunity for paraphrasing.

Mrs. Jacobson's Impressions of Other Explorations

Mrs. Jacobson continued to offer her impressions of what she had done with this and other groups since she had introduced the roles to one class. She stated that she had tried a variation to the groups of three with another class. As Mrs. Scott probed, reluctantly Mrs. Jacobson revealed that she had tried a different group size of two since she had had the students working in groups of 5 and 6 prior to the introduction of groups of three. She said: *"It was just two roles"* that she introduced to them—the questioner and the recorder—but thought that having two roles was not as effective as three. According to Mrs. Jacobson, *"To have the three roles, it is better; . . . it is more organized with three"* because *"the class playing the three roles seemed more organized."* When asked by Mrs. Scott whether she would continue to use the groups of three, Mrs. Jacobson stated that she would.

Since the introduction of the roles in groups of three, Mrs. Jacobson, although reluctant to embrace this new approach was now using the technique in all of her classes. However, this experience for her Grade 7 classes was short-lived because of the political problem which arose; as a result, the teachers decided to discontinue the use of the MLE in Grades 7 to 9. Mrs. Jacobson's class was therefore officially removed from the MLP, and so data collection for this class was discontinued.

However, by November 20, Mrs. Jacobson requested the continuation of the coaching sessions between herself and Mr. Lennox for her Grade 11 class, because as she stated, she was not comfortable teaching at this level, and this she had also informed the principal of. Hence, Mr. Lennox coached Mrs. Jacobson, and as a result a reciprocal coaching dyad emerged from this relationship as Mrs. Jacobson also coached Mr. Lennox for his Grade 11 class.

Initiating her students to the alternative approach using groups of three, Mrs. Jacobson observed the effect on the students' behaviors, continued its use with the particular class, introduced it to her other classes, sought adaptations but reverted to the particular model which she considered more effective (**Finding # 55**).

Teachers' and Students' Overview of Their Experiences of the MLP

Teachers' Voicing their Trepidation in Embracing the MLE

A measure of hesitation always attends individuals' embarking on a new process. Teachers expressed their initial fears and how they overcame them. Mrs. Scott stated: *"One of the things I have discovered with this process, notice I said 'discovered.' For the first time, I was realizing the little confidence that I really . . . had in my students' ability."* She further explained that *"Taking on this approach, I was basically discovering and learning."* Initially, she believed that *"to release them* [the students] *to think for themselves was really a time-consuming thing;"* however, *"they showed that they could do it."* Consequently, *"This approach changed my outlook. The students think for themselves now; they can do it; so it is forcing me now to find ways of bringing it out of them"* (PDP, Oct. 22, 1997). Providing the occasion for students to learn, Mrs. Scott realized that indeed they were able to do for themselves what she thought was her responsibility—to pour information from the "jug into the mug"—as a result, her approach to teaching was changing.

She was forging ways to help students experience growth through this particular way of learning. She found that this approach *"Somewhat relaxes you in a sense that you are now able to just probe them along."* Mrs. Scott explained: *"I saw it* [the approach] *working with the brighter kids"* but not the slower group. *"I am very honest when I said, I panicked. I didn't think they could do it, just leaving these kids like that and just saying try this"* (PDP, Oct. 22, 1997).

Mrs. Sinclair also voiced her hesitation:

> *I did not see how it could work initially. . . . I could see the paraphrasing helping, but the real grouping and sitting together and working out the problem, no. I was nervous. . . . Initially I was thinking 'I would not allow my other students to fall victim of this method;' so I just tried it with this one group. . . . This is one of the things I say it I will use with my other groups. This particular group just made it work; . . . I will now try it with my Second Form [Grade 8]. You see it now, it is working and you see how flexible it is within the time frame.* (PDP, Oct. 22, 1997)

Teachers,' voicing their hesitation about taking on the MLE, expressed their uncertainties and the lack of confidence they had in the process involved in this approach and in their students' ability to take on the kind of learning that the MLE demanded. However, students proved that they, too, had a mathematical history that they could draw on and, with the *tools* provided, they could achieve anything. This impelled the teachers to think differently about their roles and the nature of this approach, which can be accommodated by any group of students—not just the fast learners but the slow learners as well.

Mrs. Sinclair stated later that this approach has *"broadened her repertoire"* and has made her *"more versatile"* so that *"when you enter the classroom even if you are unprepared . . . you could put the work on the board and feel confident that the children would come up with the correct answer."* However, she noted that previously,

> *I did not have that confidence. I did not feel that I could put an unknown on the chalkboard, something that is new to them. . . . and they could use their previous knowledge and work it through and come up with the correct solution. I did not have that confidence in the students.* (Interview, Dec. 4, 1997)

Mr. Lennox also expressed his fear:

> *One of my greatest fears was as it relates to the group activity in the classroom. I felt that a lot of time would have been wasted, but with this Coaching Approach, I realized that the grouping thing can be so organized and effect a great change in the behaviors of the students. So the fear, about working in groups going to waste a lot of time, has been done away with. Also, I saw it as something very time-consuming as it relates to my style of grouping. Before, it was just a leader in the group, but now I learn it can be three persons who have specific roles, and that is what has made the difference.* (PDP, Oct. 22, 1997)

Mrs. Sinclair, adding to the difference that the MLE brought about, stated:

> *Just to add to what Mr. Lennox said, what you have in the group now is almost if not maximum participation on the part of the students. What I have observed with this method is that we have moved away from a more mechanical to a more conceptual learning. It is not mechanical, whereas previously you would get the students to follow the pattern, it is now towards more concept building. . . . What I find is that if a child does not understand in a particular class, he is given the opportunity within the group to fill the gaps. The opportunity is available within the groups to be able to question. (PDP, Oct. 22, 1997)*

Mrs. Sinclair added that this approach takes time to be established, because "*When you just get started, it is new to you, and it is new to the kids, as a result, it takes time.*" She explained: "*Not all the topics lend themselves for discovery on their own.*" But it is very important in that you "*clue them into the situation . . . to sort of probe your way into what you want them to get into; it takes a little discipline to get into, but it is worth it.*" She went on to state that direct teaching was not totally dead but "*even though we do direct teaching, it is not like how we used to do it, . . . not so much telling anymore*" (PDP, Oct. 22, 1997).

Mr. Lennox, explaining the purpose of the assignment of roles in the group, stated: "*So you find that one person does not dominate*" (PDP, Oct. 22, 1997). Mrs. Scott added: "*Believe it or not, those group-teachers are really role-playing us. They tend to behave like how a real, typical teacher behaves, and believe me they take control of those little groups.*" The assignment of roles "*fosters responsibility,*" and "*They know what it is to change roles. That responsibility was developed quickly.*" Students never wasted time because they were always occupied with the assigned tasks. Mrs. Sinclair went on to explain: *"They decide their roles in their groups. I find that they are very comfortable, so that builds rapport with each member of the group."*

Mrs. Scott elaborated that even with the rotation or reciprocation of roles in the groups, each child deduced the basic responsibility that: *"Each child will still ask questions; it is like 'Whatever role I have, I still have the responsibility of questioning.' So I think the roles lend themselves to cutting down on the dominance and use them as strengths"* (PDP, Oct. 22, 1997). Mr. Lennox re-emphasized:

> *The kinds of questions I have heard the students asking, are really showing that the kind of learning that is taking place is not just the kind where they regurgitate . . . but of getting a concept—the discovery type. So that is another plus to the coaching.* (PDP, Oct. 22, 1997)

Teachers continued to elaborate their observations and the implications of the grouping techniques. Mrs. Sinclair stated that because roles were rotated, they were *"given the opportunity to question each other, the level of frustration they usually experience—'I can't do it, it is too hard, I can't be bothered,'—is really not there anymore."*

Mrs. Sinclair, explaining what is involved, emphasized: *"They definitely have to pull from their past experiences or previous knowledge. They definitely have to use what they know to solve the problems unless they are just revising."* Mrs. Scott, going an extra mile, stated that what the students are doing in their groups, they are now taking it on individually: *"I can speak out of experience that, when they finish their homework, it is their work."* Because *"participation is being maximized"* in the group-setting, students are doing *"well. They learn. Learning is taking place on their part."* So what they had been doing in the group-setting was now being taken on individually.

Students' reflections also reinforced this observation. One student stated that she was developing her craftsmanship by *"practicing more, putting over-time work in math, . . . using all the books I can get and understand to see the different ways of solving the problems"* (8GA, Dec). Student 12GA (Dec) stated that he was also doing work on his own outside the grouping because *"I go through my text and notebook to find some of the math I don't understand and try to work them out."* *"Whenever I get a new topic, I go home some evenings and . . . practice them"* (11A, Dec8). Also, Student 13A (Dec8) stated that he made *"charts and placed them on my wall and put solutions on cassettes and listened to them. I also made up songs and practiced every night."* Also, *"sometimes when I go home I take out my math book and make up problems of my own which concern the topic that we have been doing in class. That helps me to understand more"* (9A, Dec8). So by mastering the various ways of solving particular problems in their groups, students were venturing on their own and seeking not only similar problems in textbooks and practicing them but also making up their own.

Student 10SC (Nov28) acknowledged: *"I am constructing deeper and broader understanding of the concepts, in the sense that, I am able to try other alternatives or methods in order to arrive at the same answer legally."* Even under testing conditions student 3A, (Dec1) stated: *"I didn't remember how to solve a problem using factors but on concentrating it came back to me gradually."* So even when a particular method was required under testing conditions, students' focusing on previous interacting experiences allowed them to retrieve information on an individual basis.

Embarking on the *mathematics learning experiences*, teachers were hesitant because they thought it was a time-consuming action; they were also hesitant to relinquish their responsibility of "pouring information into the mugs" and to release their students to think for themselves (**Finding # 56**). Taking on the approach, teachers' perception were changed with regard to the flexibility of the approach within the time-frame of the class period, the change in students' behaviors, the kind of learning that was taking place, and the time and effort teachers had to make to accommodate the approach (**Finding # 57**). Empowered with the responsibility to ask questions in the group-setting, students no longer experienced the level of frustration they had while working alone, but were able to draw from one anothers' past experiences and previous knowledge to solve mathematical problems, and that which they learnt in the group-setting they practiced on their own to enhance their understanding of concepts (**Finding # 58**).

Performance as a Result of the MLE

Mrs. Scott did not take anything for granted. This approach had to prove itself not only from what was being observed in the classroom with respect to students' behaviors and maximized participation but *"in addition to that, I see a turn around in terms of their performance."* Mrs. Scott had been examining the performance of her 4—Arts Girls on assignments, tests, and on quizzes:

> *Just consider the grades on the quiz that was given recently. Usually in a class, you would probably see a top eight or nine gaining an acceptable pass, what I am seeing now is that . . . you might have just nine out of the group not gaining an acceptable pass. . . . So we are seeing now that it is skewed the other way. . . . So that is the measure I have been using out of the group experience to see whether or not there has really been a turn around in terms of learning. . . . To get that sort of response over this short period of time, that is really remarkable.* (PDP, Oct. 22, 1997)

Mrs. Scott was the only one who could speak of performance at this stage. However, on November 13, Mrs. Sinclair gave a test on simultaneous equations. She had four different sets of simultaneous equations including a word problem to solve by graphing, by elimination, or by substitution. The test items were written on separate cards along with the specified method for approaching the solution. A card with one problem was given randomly to each group, but students were to solve the problem individually. There were eight groups of students in Mrs. Sinclair's class, so two groups had the same problem to solve. As they solved the problems, they were to provide explanatory statements for the steps involved. All students who were given the problems to solve by elimination and by substitution were able to provide detailed explanations for each step, although some students made simple errors in the solution. However, no one in any of the two groups that received the problem to be solved by graphing was able to solve it; no one was able to explain even the first step. One or two persons drew a box with compartments—a grid—and placed some numbers in it, but they were not able to go beyond that point. I was very curious, so I asked Mrs. Sinclair how students were supposed to have learnt the method of graphing. She told me that she had done it using direct teaching because she was short on time (Notes, Nov.13, 1997).

During Mrs. Jacobson's reflecting session on November 18, Mrs. Sinclair shared her experience. She confessed:

> *When I was doing the simultaneous equations, for the substitution and elimination methods, I used this approach. For the graphing (laughs), because I know that it involved more skills (laughs), I did the direct teaching, and they never learnt one*

> *thing! (bouts of laughter). So the other day when Mrs. McLymont took my class, her question to me was: "How did you teach this?" (laughs) I couldn't do anything more than to confess (laughs). . . . I knew she was not coming to visit that class, so I did it by direct teaching. Now I know they have to learn it themselves.* (Nov. 18)

One student, on December 5, while giving her reaction to grouping during the class interview by Mrs. Sinclair, the class teacher, recalled the event and reinforced the point made by Mrs. Sinclair. She stated:

> *Miss, what I realize is that working in groups you learn. If you were teaching us at the board we would be lost. When you taught us that graph thing Miss, graphing simultaneous equations, I did not have a clue as to what you were saying. All I had to do was to ask May what I should do; it was only then that I understood.* (5GA, Dec)

With Mrs. Sinclair's reverting to the old way of teaching even after her "near perfect" MLE class, some students found a way to get over the hurdle of lack of understanding by seeking help from their peers to understand the concepts taught by the direct teaching method.

At the October 22 PD session, the new teachers to the department, while listening to the other teachers as they shared their experiences about this new approach, were curious about how assessment was done. The question was asked: *"Take the whole thing of evaluation, in a class of say 40, with the three persons in a group—how do you assess each person?"* Mrs. Scott gave a detailed explanation, showing that each group was not really left on their own, but whatever they came up with, they shared in the whole-class so that everyone was exposed to the method they came up with. Mrs. Sinclair added: *"Some topics lend themselves to checking. . . . So right away, they can check to know if their answer is wrong or right"* (PDP, Oct. 22, 1997). Mrs. Scott also added that the approach

> *forces them to revise, too, because it is pulling on what they know. It makes them feel a part of the class, and what you will notice—probably the other teachers can attest to this—is that the alertness of the class is greater. You don't find anybody day-dreaming and going off* [in wonderland]. *They are participating; mentally and physically, they are participating. And they are more conscious of each other in the classroom now. (PDP, Oct. 22, 1997)*

Expanding on the matter of assessing the students' performance, I explained that students were not graded on the performance of their groups; group performance was not assessed. It was the individual performance of each student on the tests that were assessed. This principle was based on the premise which had already been stated: what students are able to achieve in a group-setting, they will be able to accomplish on their own and might be in a greater dimension (Vygotsky, 1978). Group-performance was not assessed in any way, as we did not want to return to the competitive-judgmental mode.

Grouping provided students with the opportunity to learn concepts by themselves and to be able to do well on tests and assignments when assessed individually (**Finding # 59**).

Teachers' Perception of the Impact of Conferencing

"Teaching" had become more real and practical for Mr. Lennox; because the approach, which included the conferencing, provided detailed mental rehearsals of the lessons. Thus, lesson planning was made more practical and worthwhile. This approach did not necessitate detailed written plans as had been required of teachers in the past. However, the necessary components of the lessons—the written objectives and activities—were all that they felt were really necessary after the detailed mental rehearsals of lessons during the planning conferences. Mr. Lennox stated:

> *What I have seen from the coaching experience is that it brings out this whole issue of lesson planning. Personally, usually I have spent a lot of time writing out some detailed lessons, and when I get to the class, many times I don't use them. But with the Coaching Approach now, all I need is really my objectives and my activities.* (PDP, Oct. 22, 1997)

Mr. Lennox further stated that, because of the effectiveness of this approach, the Ministry of Education needed to capitalize on it to relieve teachers of the demand for detailed written lesson plans, since they did not guarantee effective teaching and learning. This realization was confirmed by all teachers. Mr. Lennox stated:

> *I believe the Ministry of Education should adopt this approach so as to relieve us from the writing down of things. You can write some beautiful lesson plans and that's just it. It does not ensure that any teaching or learning is taking place. The*

> *coaching now, this is it! The Ministry of Education—they need to get it.* (PDP, Oct. 22, 1997)

Mrs. Scott added that with the planning conference employed, teachers had to prepare more thoroughly, and *"You have to know your content!"* The planning conference allowed them to, as it were, metaphorically climb a tree to have a more commanding view of each lesson they were planning to teach. As a result, clarity was provided for concepts which they did not understand. She also stated:

> *Of course, you have to prepare more! . . . The students are coming up with various alternatives. Because you are preparing more, your mind is open as well, and some things that were foggy in your mind become clearer. . . . And you know the approach is different, . . . you know that, just different.* (I.I., Dec. 9, 1997)

In her interview on December 4, Mrs. Jacobson reinforced this idea: *"The approach helps me to prepare for every class. Apart from preparing, I am ready for my class . . . you have to be ready . . . and to know what you are going to do before you get to the class."*

Teachers shared their insights and experiences about the coaching conferences. For Mrs. Sinclair, coming to a conferencing session meant having at least two methods of presenting a particular concept, not including the usual "follow my example" as exemplified by the direct teaching method. Thus, teachers were encouraged to know their material. Mrs. Sinclair stated:

> *When I know that I am going to be coached, I definitely have to prepare. You have to come to the conference with at least two methods of teaching the concepts. You have to know what you are talking about. . . . It is not, I am going to teach this and so I will do an example on the board and the children follow . . . no, it forces you to prepare.* (PDP, Oct. 22, 1997)

Mrs. Scott also provided an elaboration which highlighted thorough preparation by stating: *"In addition to what Mrs. Sinclair has said, you have to prepare the topic thoroughly. Seeing that you are not the one who will now teach the students mechanically – one step, two steps . . . you have to be flexible."* She went on to explain that, if one has eight groups of students to solve a particular problem, it is possible that *"They might come up with eight different ways, and you are in a serious problem if you know only one way."* If one knows only one solution path, *"You are going to get very rigid, and you* *will now shut down the child's whole thinking process because you don't know the process the child may use. So it forces you to know your material"* (PDP, Oct. 22, 1997).

Mrs. Sinclair went on to provide a specific example from her experience to reinforce what Mrs. Scott said in regard to preparing thoroughly and being knowledgeable of the content matter of the particular topics being taught. She explained how students came up with several methods of solution for a system of simultaneous equations in one class session and proceeded to use one method as a means of checking another in order to verify the correctness or appropriateness of the solution:

> *Like in my situation, I was specifically doing simultaneous equations, and usually I would "teach" elimination, substitution, and then graphing. . . . but in this particular class in the 60 minutes or less you got three methods and they tried to use two of the three methods to check or validate their answer.* (PDP, Oct. 22, 1997)

For Mr. Lennox, the planning conference demanded flexibility on his part. Whereas previously for the coaching conferences, he might enter with only one or two alternative ways of approaching an activity, now when the probes were being made during conferencing because of the "couplings" of his thought processes resulting from the questioning, he was able to come up with more alternatives. From his experience, he explained:

> *As one being coached by another person, I find that questions that were asked, they forced me to be flexible. So whereas I would perhaps have two or so alternatives I am going beyond that number of alternatives by the questions that I have been asked, and the probing for details.* (PDP, Oct. 22, 1997)

During the October 22 PD session the new teachers to the department had been allowed to experience a planning conference session for a class based on a set of concepts from the trigonometry topics presented by the principal. After the conferencing experience, I asked: *"What did the coaching experience do for both of you?"* One teacher's response summarized what all the other teachers stated and also provided an added dimension. *"First of all,"* according to Mr. Mutherland, *"you have to be totally prepared and also be flexible"* Also, *"because of what we did, we were better able to conceptualize what it is that we want the students to learn."* So teachers not only had to be knowledgeable of the content matter and various ways of presenting the material but also had to conceptualize that which they were inviting their students to learn.

Mrs. Scott, reflecting on all that was involved in their total experiences, deduced that their own coaching experiences reproduced themselves on the student level, producing a ripple effect. Therefore, as the teachers experienced coaching, they in turn used the same techniques with their students, and students furthered this process by using them with their fellow students. Thus, the circularity of the situation continued. Hence, PDP was able to reproduce MLE. Mrs. Scott maintained:

> *The person coaching you is making suggestions for alternatives; you are making your own recommendations. When you go to class, you are actually doing the same things; you are in return coaching the students. The students in return are coaching each other, so it is as it were a domino effect. So the coaching between the teachers actually starts the whole game. So the whole thing to me is like a ripple effect; it is passing down the coaching.* (Interview, Dec. 9, 1997)

The detailed mental rehearsal of lessons encouraged by the teachers' cognitive coaching conferences demanded thorough lesson preparation in terms of what students were invited to learn and the alternatives generated to lead students into the how of their learning experiences. The ripple effect of the formal cognitive coaching conference experiences of teachers were reproduced in an informal way in the students' mathematics learning experiences.

The planning conference encouraged thorough preparation of lessons, enhanced conceptualization of mathematical concepts teachers wish to invite students to learn, encouraged flexibility and openness to various solution paths students might take, and encouraged teachers to become aware of alternative strategies they might want to suggest that students take to arrive at a solution to problems (**Finding # 60**).

Students' Experiences With the Tool of Questioning

Among the students, a ripple "coaching" effect was reproduced as a result of utilizing the *tool* of questioning. This effect was voiced as students shared experiences similar to those of teachers. Student 007Sc (Nov20) stated: *"I understood from the group by asking questions to understand the concepts."* Also, Student 11Sc (Nov20) noted that questioning helped him to understand *"the steps I did not understand. . . . Therefore, this enabled me to perform better."* Instead of telling each other about the mistakes made, Student 010Sc (Nov20) acknowledged: *"The questioning helped me to recognize simple mistakes that I was always making."* Also, this helped because *"I had to explain everything I did, which affected my performance positively"* (12Sc, Nov20). Student 14Sc (Nov20) maintained: *"Being able to ask each other questions, my mind opened up more to the subject and helped me not to approach something with one direction."* As a result, *"Thinking about the questions helped me to solve the equation, and if I found a way to solve an equation that is hard, they found an easier way"* (Sc5, Nov20). Consequently, *"Questioning helped me to learn different methods of solving a problem"* (Sc2, Nov20), and so *"By questioning, I clarify my confusion, and by explaining to me, others receive a better understanding"* (6GA, Sept16). According to Student 9Sc (Nov20), *"The questioning helped me to put forward a solution more quickly."* Therefore, by *"being in the role of the questioner . . . you are always asking questions and whatever you did not understand, you are always asking and, therefore, you are always understanding"* (11Sc, Dec). Also, according to Student 12Sc (Dec), *"Being a questioner you ask questions; you look at every possible way; for example, you see the group members doing certain things, and you want to know if it is logical, so you ask questions looking at every different point."*

One student also stated: *"We developed alternative solutions by discussing the problems with the members of my group and listening and sharing with each other"* (4Sc, Nov28). Therefore, *"Alternative solutions were developed by mixing the methods to produce one solution, . . . as each person's suggestion was not omitted but combined"* 14Sc, Nov28). In the group situation: *"We solve problems by making up our own methods as it makes it easier to understand"* (15Sc, Nov28). Also, sharing alternative modes of solutions by various groups in the whole class led to the development of their repertoire of alternative strategies. Student 4GA (Dec) stated that her small group's only method of solution was trial and error; however, the sharing in the large group taught them several methods of solving the particular problem. The class, arriving at the various solutions, caused her to experience a good feeling, knowing that her own peers came up with these different ways. She observed:

> *Here we were solving the equations using trial and error, and we thought there was nothing else we could do to solve these problems. Then we came and wrote it on the chalkboard, but there was May's group to come up and say, "Hello, there is something else we can do about it," and then there was Ruel's group who came up and said there is still something else we can do . . . and there was Mishael's group also. It made me feel good to see that there is something else that could be done about the problem.* (Class Interview, Dec. 5, 1997)

Questioning and explaining, in student small group, enhanced understanding and clarification of concepts, encouraged open-mindedness, sharing, and exploration of alternative ways, methods of solution, or the combination of suggestions to produce solution paths (**Finding # 61**). The pathway of communication, with questioning as the starting point, established the circularity and reciprocity embedded in the connection between action and experience as the *tools* were employed and as alternative solution paths to a problem were shared (**Finding # 62**).

The Difficulty of Being Deprogrammed

Mrs. Scott, on December 4, 1997, voiced her impressions about the process they had experienced:

> *The whole thing about this thing is, it is far different from the "R-Project." Of all the workshops that we have been, this is the best that I have seen in terms of implementing the learning of mathematics, also the whole personal development of teachers, and the empowering of the students. . . . The students are empowered and they learn, and it can apply to knowledge; it can apply to anything. So you find that teachers start working together because one of the things it does .... it motivates the individual.*
>
> *It is not just the learning of mathematics, and that is why the whole thing is affecting me so much, because I am seeing the whole thing if it is not handled carefully and guarded properly, it is going to be blown out of the waters and the whole effect will not be felt. The other schools won't feel what we are feeling. As I am talking now I have a pain here in my throat because I know what it has done for us. I am not saying that we have learnt all the aspects of it as yet; we are just coming into it, and I am saying if we are not even 50% in terms of getting the*

> *whole thing and embracing the whole idea, it has done much for us and our situation here.*
>
> *You don't want this thing just to be blown out of the waters. You don't want it going down like the Titanic. It is such a beautiful thing, and it has such a future. . . . You see it coming on, and now with the whole mixing up with the "R-Project". . . . That is why I really want this to come back up, because it is really the missing link as I keep on saying. You know I am not saying it for saying it sake. I said it from the first workshop, and I will keep on saying it. It is the way to proper learning. I always had a problem with the old approach* [traditional approach]. . . . *I have not gotten the students to be going in all the aspects as yet, but you see it coming, and it is something you want to follow through with. I think the teachers here have put a lot into it in terms of us embracing it and cooperating with each other. For us to overcome our own hurdles and fears, we had to let go of our classes; . . . I think we have put in a lot. You have put in your all. So just to get it blown out . . . the fact that it is the children, it is everything. . . . We just want to see it matures. We want to see the end result of it. We want to see it works without anything else impeding it or impinging on it. We want to see the end of all of this, because we have also given much to it even though the whole plan has not yet been fulfilled in the classes, but the whole aspect of coaching each other, you know it has addressed that.*
>
> *It is not something that you want to see go out, and I am really speaking from my heart whether you are here or not here; I am speaking from my heart. I know that for my teachers we are speaking from our hearts. That is why we met to come up with the solution that maybe we just needed to find some way to separate the two projects; you weren't here; you were not around. So the type of suggestion that it is because you are here, I would not want to entertain that; I did not get that from any of my teachers.* (Reaction, Dec. 4)

Being faced with a political problem, the teachers decided during my absence from the school to remove the MLP from the Grades 7 to 9 classes. The effect this decision had on all of us was as if our hands were tied behind our backs. Mrs. Scott expressed the difficulty which had resulted from the decision made:

> *Believe me, it is so difficult; we try not to group them, but the whole approach is just a part of you; you try not to make it obvious, but it is just a part of you. It is teaching and learning. It is so difficult to be deprogrammed ourselves. We try to color it, but it is a problem, too, because it is difficult to carry through the coaching in just the fifth and fourth forms* [Grades 10 and 11] *and not in the rest of the school. Because once you are doing it, you tend to be just doing it. So when we get the liberty to do it full-fledged, then the whole thing will come out in the classes much more. It is difficult; it is difficult, but we maintain the concept because we would be stupid not to, because it aids learning and teaching, and it*

> *has kept the students rather hiked. . . . But the problem is trying to use a little piece of your approach and not your approach in trying to cover it, that is really a problem.* (Interview, December 9)

Mrs. Scott expressed the difficulty in keeping with the decision they had made not to use the MLE with the other classes they were teaching in lower school. As she said: *"The whole approach is just a part of you."* This acknowledgment was reinforced when she stated: *"Once you have been through the coaching thing and have embraced it, it has changed you as an individual for life and not just for math teaching"* (Dec. 9).

Mrs. Scott's sharing of her impressions of the impact of the process, also served to reinforce what she said about the changes that had taken place. She stated that even the principal had observed the obvious changes: *"Mr. Dyer was saying to me the other day that most teachers always want to work alone. Teachers simply want to be by themselves"* but the process had changed that mind-set. She drew reference to one of changes that had taken place with a particular teacher:

> *Take for example Mrs.* [X], *look where she is coming from. Remember the shyness, the insecurity, her always being afraid? . . . but look at the big change in her. In my department, as a matter of fact, there is a big change. You find that it* [this process] *builds interpersonal relationship because of the respect and regard for each other, all of that has taken place. I believe if you should talk with the teachers now in comparison to when you interviewed them the first time you will hear a different song. I have been here some eight years and I have never had such a relationship with some of the persons in my department. But the whole coaching and working together, in learning the trust, and the not judgmental type have broken down barriers, and most of the barriers from what we are seeing now were just merely imaginary.* (Dec. 4)

Mrs. Scott also explained how the process had changed her:

> *It has changed me from my being a judgmental person, from being judgmental with my classes, with my peers, and the education system. I am listening more. It is very very wide, not just for math. This holistic approach aids in the development of the whole person. The coaching redirects thinking and raises the students' level of consciousness and will affect all subject areas.* (Interview, Dec. 9)

Mrs. Scott, experiencing the impact of this approach, stated (we might say, in prophetic terms) that all subject areas will be affected by this approach. Mr. Lennox also reinforced this "prophecy." He stated: *"What I am hearing, too, is that they* [the students] *actually carry this skill in other subject areas."* Mrs. Scott reinforced the belief that the extended ripple effect was indeed true when she stated: *"It is now apparent in all the subject areas."* She went on to explain: *"Sometimes a teacher at first might think that they* [the students] *are cheeky, but they are not. It is a sort of response; they always think that way."* Mr. Lennox reinforced this by stating: *"It is a way of life; . . . it is really opening their minds to think; . . . this kind of approach definitely enhances learning."* According to Mrs. Scott: *"We will continue with it because of the learning of mathematics and it will impact on all the other subject areas because of the empowering aspect of it. The students are empowered, and they learn. It can apply to knowledge; it applies to anything"* (Dec. 4).

Mrs. Sinclair also voiced her perception of the package they had been exposed to and the impact it had made on her as a teacher and as a parent:

> *The whole package has broadened my repertoire of teaching mathematics, my techniques, my strategies, and my role as a mother. . . . First, you go to college, your own experience, the trial and error, what worked and what did not, and with all the training we got, and so you put some of that, but this has broadened some more, now you are more versatile when you enter the classroom even if you are unprepared.* (Interview, Dec. 4, 1997).

She also went on to state the difficulty she was experiencing with the decision the teachers had made to use the MLE only in Grades 10 and 11:

> *I try not to do much consciously, not to use this new approach in my classes in lower school, but you can't. It is like when you teach a child to use knife and fork (laughs). The child used to eat with his or her hand; now, the child might not eat with the fork, but he will not go back to using his hand. He will eat with the knife or eat with the fork. You know it is difficult.* (Interview, Dec. 4, 1997)

With the approach becoming a part of each teacher and student once they had embraced it, it was difficult not to use it consciously or unconsciously. It had been embodied. It was impossible to revert to one's old ways. Instead, the ripple effect extended the boundaries of the mathematics teaching and learning situation to expose teachers of other subjects to this way of thinking. Hence, the MLE was not confined to the math classrooms but was influencing the teaching and learning of other subjects as students employed some of the *tools* they had embraced. Teachers, having faced the decision they made to abort the MLE from Grades 7-9, found it difficult to be deprogrammed from the principles involved. As a result, it was like having their hands tied behind their backs as they tried not to use the approach.

Embracing the principles embedded in the Mathematics Learning Program (MLP), teachers experienced difficulty in being deprogrammed as they were now changed individuals not just in terms of mathematics teaching but in terms of the general principles involved in teaching and learning as each teacher became more versatile in his or her approach to the classroom teaching and learning experiences (**Finding # 63**).

CHAPTER SEVEN[6]

FINDINGS, DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

> *In the mouth of two or three witnesses shall every word be established.*
> *(II Corinth. 13:1)*
> *The whole thing about this thing is, it is far different from the "R- project." Of all the workshops that we have been this is the best that I have seen in terms of implementing the learning of mathematics; also, the empowering of the students, and the whole personal development of teachers. It embraces the whole thing. In truth, I think we will continue with it . . . because of the learning of mathematics, and it will impact on all the other subject areas because of the empowering aspect of it. The children are empowered, and they learn. It can apply to knowledge; it applies to anything. So you find that teachers start working together, because one of the things it does is that it motivates the individual.* (Mrs. Scott, December 4, 1997)

Formulating this study, which emerged as a result of my concern about the low national achievement in mathematics at the exiting high-school level and the dominance of the traditional modes of instruction in the classroom within the Jamaican context, I had to cudgel my brain to find a solution that would provide every student with *tools* that they could use under all circumstances. I sought *tools* that were self-generating, *tools* that would help them to think about their own thinking, that would help them in problem-solving situations, and that would help to build their self-efficacy. As a teacher educator, I thought of helping a set of teachers to generate the use of these *tools* first, and then, they in turn would help their students to work with them also. So an alternative approach for the teaching and learning of mathematics utilizing cognitive coaching during the Professional Development Process for high-school mathematics teachers was conceptualized.

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[6]

a. A version of this chapter has been prepared as part of a paper presented at the April 1998 American Educational Research Association Annual Meeting, San Diego, California, U.S.A., and has been published. Mclymont, E.F. & da Costa, J. L. (1998). ERIC Document Reproduction Service ED 420 637

b. A version of this chapter has been prepared as part of a paper presented at the 1998 International Multicultural Conference University of Alberta, Canada, and has been published. McLymont, E. F. (1998). International multiculturalism 1998: Preparing together for the 21st century, pp. 236 - 250.

c. A version of this chapter has been prepared as part of a paper presented at the 3rd African Society Conference 2000: Prospects for an African Renaissance. University of Alberta, Edmonton, Canada. February 2000.

Thus, this study was conducted to conceptualize, introduce, and examine the development of an alternative approach to professional development for high-school mathematics teachers, to generate an approach to tap students' mental resources in the mathematics classroom through the *mathematics learning experiences* (MLE), and to explore the generation and accommodation of this alternative approach for the teaching and learning of mathematics in the Mathematics Learning Program (MLP).

This chapter provides a summary of the findings, the discussion in light of the literature and from my own perspective, the conclusions, recommendations for theory and practice, and a re-examination of the method.

A Summary of the Findings

The findings of the study suggest that the circularity and reciprocity involved in the utilization of *tools* of *Cognitive Coaching Discourses* as the vehicle for professional development for collaborating teachers of the same subject has generated an alternative approach for teaching and learning. The original intent to generate an alternative approach to the direct teaching that has been traditionally employed generated not only an alternate approach for teaching and learning in the everyday classroom context but suggested an alternate approach for professional development and an approach to research methodology, a methodology unique for gathering and analyzing data. The creation of a climate for professional development and the universality of the nature of the approach as it related to teachers as collaborators and students as collaborators emerged from the analysis of the data. The teachers' and students' perspectives about the generation and accommodation of the MLP are also presented. The following summary of findings has been generated from the analysis of the data as the research questions were addressed.

How Was the Professional Development Process (PDP) Utilizing the Vehicle of Cognitive Coaching Perceived and Accommodated by Teachers of Mathematics in the Jamaican Context?

The utilization of the vehicle of cognitive coaching created the climate for the PDP. This process was perceived as an alternate approach for teaching and learning—the *Coaching Approach*. The *Coaching Approach* was perceived universal in nature and was accommodated through the elimination of teacher isolation.

Creating the Climate for the Professional Development Process

Finding # 1: The teachers' willingness to participate in and generate a program to enhance pedagogical principles in a school context, the principal's and administration's recognition of the teachers' needs to share and to be involved as a group in this venture, and the active involvement and participation of the principal and the administration were essential to provide support, to create the climate, and to develop the culture for the accommodation of the PDP for teachers and the MLE for students.

Finding # 2: Teachers recognized their inability to optimize learning on a larger scale in each of their classes and attributed this inability to make a difference to numerous factors that impinged on students' learning.

The Coaching Approach: An Alternate Approach for Teaching and Learning

Finding # 3: Perceiving this approach as different from the traditional approach, teachers were convinced of their need for an alternate approach to bridge the gap between their mode of teaching and the way their students as learners learn.

Finding # 4: The employment of the *tools* of *cognitive coaching* generated interactive *Cognitive Coaching Discourses,* which further generated an alternate approach to direct teaching—The *Cognitive Coaching Approach* for teaching and learning.

Tools of Cognitive Coaching → Cognitive Coaching Discourses → Cognitive Coaching Approach

Tools of Cognitive Coaching → Coaching Discourses → Coaching Approach

Finding # 5: The *Coaching Approach* encouraged individuals involved in the teaching and learning communities to be flexible.

Finding # 6: The *Coaching Approach* induced reflection, which is the act of making meaning of one's thoughts and experiences, and providing continuity to the development of ideas as *Reflective Coaching Discourses* were generated.

The Universality of the Coaching Approach

Finding # 7: The *Coaching Approach* facilitated learning by understanding as the act of experiencing this process triggered the creative process of critical thinking that led to mastery and discovery learning.

Finding # 8: The *Coaching Approach* encouraged a non-judgmental atmosphere, freedom of expression, and effective communication through the removal of positive and negative verbal and non-verbal evaluative messages from discourses.

Finding # 9: The *Coaching Approach* promoted learning by discovery as students in their groups with defined roles, discovered/ "uncovered" mathematical concepts and principles for themselves as they recognized their own abilities to solve mathematical problems and became less dependent on the teacher, whose role shifted from the expository mode toward one of a mediator.

Eliminating Teacher Isolation

Finding # 10: The *Coaching Approach* eliminated teacher isolation through collaboration, transformed relationships by generating better understanding between and among teachers, and enhanced teachers' states of mind as the opportunities to share as a group and to coach one another promoted team work.

Finding # 11: The *Coaching Approach* promoted freedom of expression and development of interactive *Discourses* through the generation of a trust-building, secure, and relaxing environment. Because no value judgments were placed on individuals' ideas, everyone participated and felt safe to express and explore their thoughts and ideas because they were respected and valued.

Finding # 12: Trust exists when a comfortable atmosphere is generated and when positive feelings of openness and willingness to share are encouraged. On the other hand, trust may be eroded when judgments are made.

Finding # 13: The *Coaching Approach* brought about a transformation from a formal, individualized, and isolated world to one that manifested itself in professional empathy, in the building of trust, and in empowering teachers to be in command of the teaching and learning context.

What Were the Teachers' and Students' Perceptions of the Generation and Development of The Mathematics Learning Program (MLP)?

The Tools for Cognitive Coaching Discourses

Finding # 14: Collaborative grouping, with each individual assigned a specific role allowed for the sharing of different perspectives toward the solution of problems, led to an increase in the utilization of the knowledge and skills each person brought to the learning situation, served as a basis for building trust, and freed teachers from the act of lecturing.

Finding # 15: A questioning technique that impelled thinking, generated probes, incorporated wait-time, allowing enough time for reflection and processing of information and signaling respect and faith in the person's ability to respond effectively to the cognitive tasks at hand served as an alternative to "telling" in the teaching and learning context.

Finding # 16: Paraphrasing is listening intentionally and communicating what is understood. It serves the purpose of validation and clarification and leads to the next question.

Finding # 17: The trust-building tools of *Cognitive Coaching Discourses* that included grouping in the collaborative setting with the assignment of specific roles, techniques in questioning including wait-time, paraphrasing and probing, and body language were considered important cornerstones of the MLP because they generated trust, rapport, and effective interactive discourses in the teaching and learning context.

Finding # 18: The time-lapse between the series seminars provided teachers with the opportunity to begin to employ, in an informal setting, some of the *tools* they were exposed to during the seminars, to begin to recognize their weaknesses in the communication process, and to begin to remedy these weaknesses.

Finding # 19: Teachers' initiation to the tool of conferencing led to an investigation of how student group-structure could be brought into the classroom-setting; the plans made were effected and their immediate impact was observed and reflected on, a process which led to the deduction of the difference between the process of evaluation and the process of cognitive coaching.

Mrs. Scott and Her Classes

Finding # 20: Generating the MLE with her 4—Arts Girls, Mrs. Scott experimented with the *tool* of grouping with assigned roles; students exhibited a marked change in their attitude to mathematics and were learning more, discovering more, practicing more, and understanding more and at a faster rate.

Finding # 21: Mrs. Scott's role was changing from that of a lecturer to that of a coach; she was also making her own applications of the coaching techniques for the students' *mathematics learning experiences.* Hence, the *Coaching Approach* seemed to be reciprocal and circular in nature; as the teacher questioned the students in their groups, the students in return questioned the teacher and questioned one another within their groups.

Finding # 22: The *Mediated Discovery Approach* is the process by which learners in small groups with assigned roles employ mediatory *tools* to draw from and to pool their experiences so as to explore or exhaust the "couplings" of their thoughts and ideas to solve problems on their own.

Finding # 23: Creating a trusting atmosphere for the alternate approach in her class, Mrs. Scott embraced teamwork that transcended the borders of the isolated classrooms; she gave students opportunity to voice their thoughts as they occurred so the meaning they intended could emerge.

Finding # 24: *Reciprocal Mathematics Teaching* (RMT) is an alternative approach to *Mediated Discovery*; in this approach, the class-teacher employed direct teaching; students within their groups reciprocated by employing direct teaching of the same concept(s), while other group members questioned the student who was providing the explanations.

Summary of the Students' Perception of Their Experiences

Finding # 25: Grouping by students' choice provided students with the opportunity for friends to work together, to laugh together, to listen to each other's views, and to be interested in each other to ensure each understood through team-work and co-operation.

Finding # 26: Grouping by students' choice, with the assignment of roles, provided a setting in which each was active in his or her role and contributed to the solution of mathematical problems through pooling ideas and opinions, motivating each other, communicating better with each other, and helping each other not to approach solutions in a one-track way.

Finding # 27: The employment of group roles promoted feelings of equity in terms of the opportunity and freedom to ask questions, to give and accept explanations, to talk and share thoughts and ideas so that students could give and receive help from their peers and build the confidence in themselves that they had the ability to accomplish mathematical tasks (interdependence builds efficacy).

Finding # 28: The employment of the roles helped students strive for excellence and mastery of the subject and generated a comfortable setting for them to share their views, discuss, agree and disagree; identify and expose their own as well as others' weaknesses and mistakes; strengthen their problems-solving skills to grasp principles and to understand problems and solutions better; and to make mathematics interesting and understandable (roles: Craftsmanship).

Finding # 29: Random grouping with group sizes of three provided students with the opportunity to choose, for their working-groups, friends with whom they felt comfortable to work; larger group sizes did not engender the same level of caring and maximum participation because students were grouped with those with whom they were not familiar, and so they were not as open and concerned about one another, weaknesses were unnoticed, and they did not think as a group.

Finding # 30: Questioning helped students improve their understanding and performance by allowing them to have open minds and by providing them with opportunities to recognize their errors, to seek clarification, to investigate, to invent their own methods of solution and to provide explanations for problems, for solutions, and for decisions made (Questioning: craftsmanship).

Finding # 31: Explaining aids understanding and performance by providing opportunities for students to communicate and comprehend what was not understood, to clarify misconceptions, to grasp concepts better, to enhance communication, and to overcome weaknesses and the tendency to make mistakes (Explaining: craftsmanship).

Finding # 32: Providing explanations presented different levels of thinking that aided understanding and helped individuals who were explaining their ideas to have a clearer understanding as their thoughts and ideas were verbalized.

Mrs. Sinclair

Finding # 33: Embarking on a personal and individual translation of her PDP experiences in the classroom, Mrs. Sinclair started to initiate her students to grouping and to utilize the non-judgmental verbal and non-verbal responses by giving voice and listening to her students more. This enabled them to generate respect for one another's ideas and to create a relaxed setting to allow students to think and clarify their thoughts.

Finding # 34: Through questioning, the planning conference "forced" the sequencing of concepts and activities, led to thorough preparation, served to clarify details, and helped Mrs. Sinclair to know exactly what she was going into the classroom to "teach."

Finding # 35: Using the Mrs. Sinclair's terminology for the mediatory kinds of questions—"coach"—the students, encouraged to coach the teacher during the lesson in the large-class setting, were initiated into the kinds of questions they should ask one another in their small-group setting.

Finding # 36: Students "coaching" Mrs. Sinclair served to empower her. Anticipating the students' questions, she sought various means to conceptualize the concepts she was inviting the students to learn.

Finding # 37: Being initiated into the alternative approach, Mrs. Sinclair's students, in their small groups, were able to "uncover" mathematical concepts, leading them away from mechanical learning to conceptual understanding.

Finding # 38: The "states of mind," utilized as *diagnostic tools* by teachers, served as the means used to examine teacher's and students' behaviors during the employment of the alternative approach.

Finding # 39: Utilizing the *Mediated Discovery Approach* in the student small-group setting, Mrs. Sinclair served only as facilitator; with every student participating, they drew from their mathematical skills and used their previous mathematical knowledge to arrive at the various solution paths to problems.

Finding # 40: The setting for the *Mediated Discovery Approach* with the small-group context created a new social and mental environment for learning, and so Mrs. Sinclair's students felt good about themselves and were willing to explore, discover, and investigate solution paths to mathematics problems.

Mr. Lennox

Finding # 41: Embarking on the translation of his PDP experiences, which he claimed had raised his consciousness and made him aware of how to put things in place for the teaching and learning context, Mr. Lennox began to employ nonjudgmental verbal and non-verbal *tools* for effective teaching and learning. As a result students' responses were positive as students revealed no fear to try to solve mathematics problems

Finding # 42: Reflecting on his engagement in the planning conference discourse, Mr. Lennox agreed that he was allowed to mentally rehearse what he had planned. His consciousness was raised to the possible situations that might occur in the particular context, and this awareness generated a level of confidence in him and encouraged flexibility on his part.

Finding # 43: During the reflecting conference discourse, Mr. Lennox reinforced his belief that the pre-conference discourse prepared him for the unexpected, as it had already raised his consciousness about the various possibilities that might occur because he always had to be thinking of alternatives. As a result he was impelled to be flexible and was able to think on his feet and to deal with any turn of events because he was developing a level of tolerance and learning not to be judgmental.

Finding # 44: Mr. Lennox seemed to be reluctant to release the students totally to think for themselves although he provided them with "windows" of opportunities and saw that this alternative approach empowered students in their roles, enhanced their confidence level, gave them the opportunity to contribute and to share ideas with one another while working together as a group, respecting one another's opinion, encouraging one another to make suggestions for solutions to problems, and ensuring that each understood the concepts to be learnt.

Mrs. Sinclair's and Mr. Lennox's Students' Perceptions

Finding # 45: Being initiated to questioning in the small groups seemed mechanical at first, but students were provided with the opportunity in their groups to express their views, to listen to each other, to pool their ideas, and to ask why, how, etc. when errors were identified and when clarification was needed to ensure understanding.

Finding # 46: Explanations in the small groups enhanced understanding of what was being explained. Also, as ideas were verbalized, understanding was enhanced; recall of previously learnt concepts took place and a better understanding of those concepts was also achieved.

Finding # 47: Employing the roles in the small groups, students generated positive attitudes as they participated, learned to cooperate with one another, got to know and understand each other, and related to and reasoned with each other in a comfortable and friendly environment. This made each student more self-confident because group members were friendly and understanding even when some did not understand.

Finding # 48: Employing the roles in small groups, students learned from each other in an interesting way. They were provided with the opportunity to work together and to help each other to work carefully step by step; each was made comfortable to be wrong about anything as mistakes were identified and suggestions for correction were made by group members while solutions to problems were sought.

Finding # 49: Employing the roles in small groups, students became more open-minded towards the solutions to problems as they solicited and shared their ideas, opinions, and methods and ensured that each understood before they moved on. Thus, they learned different solution paths for the same problem.

Finding # 50: Employing the roles in small groups, students had the opportunity to explore each other's thoughts and to identify whether solution paths were correct or not. Although each might suggest a different path, when ideas were pooled each solution was recognized as correct. Hence, the various solution paths impacted students' understanding as they learned from each other different ways to solve the same problem.

Finding # 51: The implications suggested by students as a result of the employment of roles in small groups were that they learnt to be more disciplined; they could now attempt to solve any problem; and, during a test, if time was running out, they could use the shortest method or if they forgot a particular solution path, they might be able to recall another to solve a given problem.

Finding # 52: The employment of roles in small groups impacted negative feelings and difficulties experienced when working alone and had long-term implications for learning to work collaboratively in the workplace and at higher institutions of learning.

Mrs. Jacobson

Finding # 53: Attending only one day of the June seminars, Mrs. Jacobson was not exposed to the processes involved in the use of some of the *tools*; however, being exposed to the tool of conferencing impacted the way she prepared her lessons.

Finding # 54: The reflecting conference discourses provided opportunities for Mrs. Jacobson to be aware of and reflect on her rigidity in the teaching and learning context and her unwillingness to release her students to think for themselves.

Finding # 55: Initiating her students to the alternative approach using groups of three, Mrs. Jacobson observed the effect on the students' behaviors, continued its use with the particular class, introduced it to her other classes, and sought adaptations but reverted to the particular model which she considered more effective.

Teachers' and Students' Overview of Their Experiences of the MLP

Finding # 56: Embarking on the *mathematics learning experiences,* teachers were at first hesitant because they thought it was time-consuming. They were also hesitant to relinquish their responsibility of "pouring information into the mugs" and to release their students to think for themselves.

Finding # 57: Taking on the approach, teachers' perceptions changed with regard to the flexibility of the approach within the time-frame of the class period, the change in students' behaviors, the kind of learning that was taking place, and the time and effort teachers had to make to accommodate the approach.

Finding # 58: Empowered with the responsibility to ask questions in the group-setting, students no longer experienced the level of frustration they had while working alone, but were able to draw from one another's past experiences and previous knowledge to solve mathematical problems, and what they learnt in the group-setting they practiced on their own to enhance their understanding of concepts.

Finding # 59: Grouping provided students with the opportunity to learn concepts by themselves and to be able to do well on tests and assignments when assessed individually.

Finding # 60: The planning conference encouraged thorough preparation of lessons, enhanced conceptualization of mathematical concepts that teachers wished to invite students to learn, encouraged flexibility and openness to the various solution paths that students might take, and encouraged teachers to become aware of alternative strategies they might want to suggest that students could take to arrive at solutions to problems.

Finding # 61: Questioning and explaining in student small groups enhanced understanding and clarification of concepts, and encouraged open-mindedness, sharing, and the exploration of alternative methods of finding solutions, or the combination of suggestions to produce solution paths.

Finding # 62: The pathway of communication, with questioning as the starting point, established the circularity and reciprocity embedded in the connection between action and experience as the *tools* were employed and as alternative solution paths to a problem were shared.

Finding # 63: Embracing the principles embedded in the Mathematics Learning Program (MLP), teachers experienced difficulty in "being deprogrammed." They were now changed individuals not just in terms of mathematics teaching but in terms of the general principles involved in teaching and learning. Each teacher became more versatile in his or her approach to the classroom teaching and learning experiences.

In Retrospect

Within the situation of my research, both within the schools and classrooms and within my own thinking, were numerous examples of cognitive coaching "working" to change and improve student learning and teaching methodology. In my reporting of the research, it would appear as if I highlighted only the positive aspects of the *Cognitive Coaching Approach,* but in reality I sought to capture the whole as well as aspects of all the basic components that comprise this autopoieic activity. The cases of the teachers, unique to themselves, under close examination are not considered to be totally positive. Yet, with time that which was mediated initially was being mediated in the long run. It is likely that such an approach, although it worked well within this context, might not always work well in any situation. Certainly, people's individuality, their personal histories, and their circumstances impact any curriculum change.

The question remains therefore, how to translate these findings into recommendations that would improve teacher education and teaching practice. Specifically, how should the findings of this research manifest themselves in teacher education programs to improve mathematics teaching and learning? To help move towards the implications of my recommendations, it might be wise to synthesize the findings that are considered the most salient into a next level.

A Synthesis of the Main Findings

The support of the principals and administrators and the teachers' recognition of their inadequacy to optimize and maximize students' learning were essential for the accommodation of PDP and MLE.

Embracing the *tools* of *Cognitive Coaching* which generated *Cognitive Coaching Discourses*, teachers generated a different approach for teaching and learning; one that promoted flexibility, induced reflection and critical thinking, and created a thirst to "uncover" mathematical concepts in a non-judgmental atmosphere—the *Cognitive Coaching Approach*.

The *Cognitive Coaching Approach* eliminated teacher isolation and promoted team work; generated professional empathy, trust-building, openness, and respect; and changed teachers' roles from the expository mode toward one of a mediator, thus empowering them in the teaching and learning context.

The utilization of the *tools* of *Cognitive Coaching Discourses* impelled critical thinking, maximized the utilization of each person's knowledge and skills; enhanced positive attitudes and communication; and empowered teachers and students in their respective groups to voice their thoughts, share their views, and laugh and work together as a team.

The utilization of the *tools* of *Cognitive Coaching Discourses* encouraged problem solving, thorough preparation, generated alternatives, and induced mental rehearsal, investigation, and discovery—*Mediated Discovery*—which encouraged a move away from mechanical learning to conceptual understanding and created a new social and mental environment for learning.

The *diagnostic tools* of the *Coaching Approach* served to generate reflection. Teachers metacogitated, examined their own behaviors, monitored them, and sought means by which their behaviors could be improved.

Embracing the mediatory tools of the *Coaching Approach,* teachers experienced the difficulty of "being deprogrammed" as that which was mediated to them had now become a part of their repertoire; they were now acculturated in this mode of thinking—cognitively modified—hence, the difficulty of unlearning these principles that enhanced teaching and learning and that reflected the circular and reciprocal nature of this approach.

The formal cognitive coaching experiences of the teachers were reproduced in an informal way in the students' *mathematics learning experiences*. Hence, PDP reproduced MLE. (PDP → MLE).

Discussion

Creating the Climate for the Professional Development Process

From the analysis of the data, I have deduced that the teachers' willingness to participate in and generate a program to enhance pedagogical principles in a school context, the principal's and administration's recognition of the teachers' needs to share and to be involved as a group in this venture, and the active involvement and participation of the principal and the administration were essential to provide support, to create the climate, and to develop the culture for the accommodation of the PDP for teachers and the MLE for students (**Finding # 1**).

Sharing the intent of my study and encouraging the principals' active participation, I was successful in raising their level of consciousness about the need for teachers to participate as a group in a fluid and dynamic professional development setting, that would lead to the enhancement of student learning of mathematics. Communicating the intent of this study and inviting principals and their administration to participate, I extended the horizons of the context of the intended classroom learning experiences to include the school climate and the development of a culture that was systemic. The sharing with the principals at this level generated interest and acted as an "eye-opener" for one principal to recognize the need for teachers to share as "subject-collaboratives" through the Professional Development Process (PDP) and to generate the students' *mathematics learning experiences* (MLE). As a result, the principal recognized his need to encourage his teachers to participate in the study, to support the teachers, and to provide them with the freedom to share with one another and to set the pace for the development of an appropriate climate not only for teachers but also for students.

Therefore, accommodating the time for teachers' individual interviews, the series of seminars, the ongoing coaching sessions, the slot of time for all teachers to be able to meet and share as a group, taking teachers' classes, informally providing support and encouragement to teachers, and making himself available for me to have frequent interaction with him, all served to create the climate and to generate and develop the culture for the generation and accommodation of this alternative approach.

The *Professional Standards for Teaching Mathematics* (NCTM, 1991) supports this position because it states that, to be able to develop the mathematical power of all students, it is necessary to create a new environment in which teaching and learning of a different nature than the usual practice can be carried out. Because teachers have not experienced the kind of teaching that they are expected to do, it is imperative that they be engaged in a similar learning situation. This takes time to develop, and so "appropriate and on-going professional development is crucial" (NCTM, p. 3). The PDP provided the on-going professional development and collaboration throughout the school term. It also provided teachers with the opportunity to interact and share their ideas about teaching and learning while engaging in the alternative approach.

The *Professional Standards for Teaching Mathematics* (NCTM, 1991) also emphasized that "for teachers to be able to change their role and the nature of their classroom environment, administrators must …encourage [and] support" them (p. 3) because "change is difficult and will take time and reliable, systematic support" (p. 3). It further explained that "decisions made by others can enable teachers to move toward the vision of teaching described . . . or can constrain the mathematics program in ways that cripple efforts to improve teaching" (p. 7).

The support provided by the principal and his administration to provide the teachers with the climate and culture for their learning to take place was reciprocated. Teachers, in turn, generated a similar climate and culture so that student learning could occur in a similar manner to theirs, thus producing a ripple effect starting with the small community of teacher-learners to include the larger community of student-learners. Hence, "the environment in which teachers teach is as important to their success as the environment in which students learn is to theirs" (NCTM, 1991, p. 7). The culture to bring about learning by understanding was therefore generated, a culture in which one could think, could seek to understand, could express thoughts and ideas aloud, could investigate and experiment, and could reflect or metacogitate. This culture, according to Bruner (as cited in Brown 1997), is "the way of life and thought that we construct, negotiate, institutionalize, and finally . . . end up by calling 'reality' to comfort ourselves" (p. 399)

Because teaching and learning are concerns for all those involved in the school system, for the success of any program Fullan and Miles (1992) proposed that "local implementation by everyday teachers, principals, parents, and students is the only way change happens" (p. 752). Hence, from the inception of such a program, power was passed to those who would be involved in making the teaching and learning climate a reality. Thus, **Finding # 1** is therefore supported by Fullan and Miles and also by Lewis (1997), who stated that everyone in the school community should be involved in the creation of a shared purpose.

Finding # 1 is also endorsed by Lewis (1997), who stated that several researchers have recommended that school structures should be redesigned to support teacher learning and collaboration when serious attention is being given to practice. Lewis also noted that researchers who have worked extensively with professional development in schools have found that re-thinking schedules for staffing patterns to create blocks of time for teachers to work and plan together enabled the accomplishment of desired goals. Fullan and Miles (1992) also support this idea, stating that only when "requirements of change are met through the provision for release time or through a redesigned schedule that includes space for the extra work of change" (p. 750) is success likely. In Reforming the Teaching Profession (1997), Darling-Harmmond also provided support for **Finding # 1** by stating that opportunities for teachers to serve as critical friends should be created so that they can observe each other while teaching. Doing so requires re-thinking the schedule to make time available for teachers. In the same vein, she stated that principals and assistant principals could substitute for teachers in their classes (Reforming the Teaching Profession). According to Wood, Killian, McQuarrie, and Thompson (as cited in Hodges, 1996), "Principals are gate keepers of improvement in schools . . . and what principals do . . . is important to the success of a staff development effort to improve school practice" (p. 74).

The purpose of my unscheduled meetings with the principal throughout the school term is also supported by Fullan and Miles (1992) as they argued that initiatives that engender change cannot run by themselves. Change requires power. Therefore, keeping administrators informed about what was happening was crucial to generating the climate and culture for this program. This interaction also kept me informed about the administrator's impressions of what was taking place in the teaching and learning context as he interacted with teachers and students and made his own observations. The development of collaboration/interdependence between the principal and me and among and between the various levels of the hierarchy within the school organization was important for the generation of the culture for this program that targeted teachers as individuals as well as a group—the Mathematics Learning Program (MLP).

The collaboration of teachers of the same subject is identified by Lord (as cited in Little, 1993) as an alternative paradigm of professional development. This alternative paradigm, Lord stated, "encompasses (a) teachers' knowledge of academic content, instruction, and student learning (b) teachers' access to a broader network of professional relationships and (c) teacher leadership in the reform of system-wide structures" (p. 134). Thus, as subject collaboratives, teachers were equipped individually as well as collectively (Little, 1993) as they engaged in the PDP by employing the *tools* of cognitive coaching as the chief vehicle for collaboration. Joyce and Showers (1995) stated that they found that coaching flourished best in situations in which principals took active roles in supporting and providing help to teachers as they collaborated and became less isolated.

Creating an interest in and setting the pace for collaboration, I invited teachers to reflect on their previous practice individually. By doing so, they recognized their inability to optimize learning on a larger scale in each of their classes and attributed this inability to make a difference to numerous factors that impinged on students' learning (**Finding # 2**). Recognizing these obstacles and their inability to eliminate the various factors that impeded their ability to make significant changes in the teaching and learning of mathematics, teachers were open to suggestions about how they could be empowered to make a difference to student learning.

Thus, as I invited them into an experience that would be very different from the usual practice and one that might make a difference for teaching and learning, the enactment of this experience generated a setting for experimentation and investigation. As a result, teachers explored ideas, concepts, and processes and generated discourses as they reflected on the observed effects on their own actions and experiences, constructed their own meanings, and projected ideas for the implications for students' learning of mathematics. Generating these discourses, teachers also contributed to creating a curriculum, an environment, and a climate for the accommodation of an alternative approach to enhance the development of the mathematical power of all students.

The Coaching Approach: An Alternate Approach for Teaching and Learning

Perceiving this approach as different from the traditional approach, teachers were convinced of their need for an alternate approach to bridge the gap between their mode of teaching and the way their students as learners learn (**Finding # 3**). Experiencing this approach, teachers reflected on their previous methods of teaching—the traditional approach, direct teaching—and compared how they were now learning with how their students learnt. Reflecting on their experiences, they deduced that students lacked conceptual understanding of what was taught and could not make connections and use concepts and ideas learned in one context in another. Consistent with the findings of the TIMSS (1996) and like the US teachers, the teachers did not lead their students to develop concepts or to invent new solutions or procedures on their own. Hence, they did not encourage thinking in their classrooms. Consequently, they visualized the principles of the new approach they were being exposed to as important to bridge the gap between what they wanted their students to accomplish and what their students could accomplish. Hence, the employment of the *tools* of *cognitive coaching* generated interactive *Cognitive Coaching Discourses,* which further generated an alternate approach to direct teaching—The *Cognitive Coaching Approach* for teaching and learning (**Finding # 4**). The *Cognitive Coaching Approach* was termed the *Coaching Approach,* which was the name given by the teachers to identify their experiences while employing the *tools* of cognitive coaching. Also, the term *Coaching Discourse* is used instead of *Cognitive Coaching Discourse*.

Coaching Discourse

Coaching Discourse is a term which I coined as a result of the perturbations of my thoughts after my data collection but before I entered the analysis stage of my research. As I tried to reflect on and make meaning of what actually transpired in the teaching and learning situation during my data collection period, I interpreted what we had done not purely as cognitive coaching, nor as purely "discourse."

The concept of cognitive coaching was explored with the teachers. Therefore, the term "coaching" was used extensively by the teachers, their students, and me. Neither was the process purely "discourse," a term which I had used throughout the seminars; but it was a process that subsumed cognitive coaching and discourse. Consequently, with the constant perturbations of thoughts as to what it was not and my explorations of the literature on discourses, I was led to the first stage by coining the term—*Discourse Communication*. However, further perturbations of thoughts through the voicing of my thoughts and the questioning of members of my dissertation committee aided in the coming together of thoughts which existed as separate units. Thus, this interaction helped me determine that which was recondite, hence the bringing forth of the concept "*Coaching Discourse*."

Discourse involves ways of knowing and ways of communicating the substance of ideas that integrates words, thoughts, actions, beliefs, values, attitudes, gestures, social identities and nonverbal expressions and is sustained in an interactive setting. It is a tool used for the establishment and distribution of knowledge and to convey the intended messages that one strives to communicate through language (Gee, 1996; Hicks, 1995; Johnson & Marrow, 1981; NCTM, 1991; & Riley, 1985).

On the other hand, cognitive coaching, according to Costa and Garmston (1994), is the means of conveyance which takes a person from where he or she is to where he or she wants to be. It is a way of thinking which utilizes the employment of certain strategies, a way of working that enhances the individual's perception, decisions, and intellectual functions. Thus, the inner thought processes are changed to improve overt behaviors and in the long run to enhance learning. Cognitive coaching establishes and maintains trust in self, relationships, processes, and the environment. It facilitates mutual learning and enhances growth of an individual towards autonomous behaviors while simultaneously aiding the development of interdependence (Costa & Garmston).

Costa and Garmston (1994) maintained that cognitive coaching draws on previous knowledge and intuition to guide, hone, and refine actions. It pursues ambiguities and possibilities to create new meanings and seeks perspectives beyond self to generate resourceful responses. As a result, it seeks balance between and among aloneness and togetherness, action and reflection, and personal and professional growth. It further explores choice between self-assertion and integration with others (Costa & Garmston).

Hence, *Coaching Discourse* provides the "how" for ways of knowing, communicating, and being. It is an extension to cognitive coaching to include not only formal conferencing with teachers but informal conferencing, and not only with teachers but also with students. It is also extended to include larger communities of three or more persons instead of just dyads, both on the teacher and student level. It is extended to include not just interactions within the formal setting of conferencing but the constant on-going informal interactions in informal settings both on the student level and teacher level. These informal interactions are not just discussions or conversations; they employ the principles and *tools* employed in cognitive coaching to bring about *Coaching Discourse*.

Coaching Discourse can, therefore, be formal as well as informal. Cognitive coaching as a method is therefore modified to become *Coaching Discourse*, an approach for teaching and learning which has a universal nature. As a result of the flexibility and the universal nature of *Coaching Discourse,* other types of *Coaching Discourses* can be generated on the teacher level as well as on the student level. *Coaching Discourse* is the reciprocal utilization of verbal and non-verbal trust-building tools of cognitive coaching for the enhancement of communication and understanding and the exploration of ideas, beliefs and values to generate a process—the *Coaching Approach*.

Tools of Cognitive Coaching → Cognitive Coaching Discourses → Cognitive Coaching Approach

Tools of Cognitive Coaching → Coaching Discourses → Coaching Approach

The *Coaching Approach* encouraged individuals involved in the teaching and learning communities to be flexible (**Finding # 5**). To be able to work with others in a collaborative setting trust must exist, and to develop trust, individuals have to be flexible to be able to accept the opinions and ideas of others without passing judgments. By accepting and appreciating the points of view of others, individuals are able to explore the ideas that are suggested to understand what is being presented. Thus, the positive intents are examined. Elaborations, clarification, and links to other ideas can come about and will lead to understanding for all the parties involved.

If one is not flexible, then the thinking on the part of all involved will be constrained. Unique ideas and thoughts that were about to be "born" suffer "premature death" simply because those to whom they are expressed might not be flexible. However, when the differences in how a thought is expressed and in what is expressed are accepted by flexible individuals and not construed as wrong, they are used as launching pads to arrive at a larger picture. This acceptance sets the pace for exploration and discussion of those ideas expressed. Flexibility, according to Costa and Garmston (1994), "involves the ability to step beyond oneself and look at a situation from a different perspective" (p. 135) and is therefore necessary for collaboration, problem-solving, and fostering a climate for risk-taking, experimentation, critical thinking and reflection.

The *Coaching Approach* induced reflection, which is the act of making meaning of one's thoughts and experiences and providing continuity to the development of ideas as *Reflective Coaching Discourses* were generated (**Finding # 6**). As individuals engaged in a collaborative setting for teaching and learning, personal meanings were created, interpreted, and negotiated. The environment created was one in which communication took place, where clarity in meanings and intentionality of messages conveyed were encouraged. Such a trust-building setting can generate, according to Riley (1985), "discourse as a tool for the establishment and distribution of knowledge" (p. 2), where "participants collaborating together . . . learn one another's meaning from the information they exchange" (p. 4), thus, creating "common meaning through" their "sharing and comparing information" (p. 7). However, "This interaction requires the negotiation of meaning through interaction." Hence, Riley stated that he refers to this "negotiation as discourse" (p. 7). He further stated that "this interactivity is a necessary condition for the enactment of any discourse" (p. 7) and is essential for *Reflective Coaching Discourses.*.

Reflective Coaching Discourses

Reflective Coaching Discourses emerged out of the use of the trust-building *tools* of cognitive coaching as teachers reflected formally and informally on the transpired *Coaching Discourses*. It was an interactive social process in which ideas, knowledge, notions, problems, and intent were explored through the reciprocity in roles. It was concerned with understanding, as the questions generated during the discourse of collaborative coaching dyads probed or mediated clarification, elaboration, and intentionality. *Reflective Coaching Discourses* impelled teachers to listen as they acknowledged, empathized, synthesized, summarized, and restated what was understood from the message conveyed. It involved standing aside and looking back on all the activities that teachers engaged in. It is generated by reflecting on the experiences in the path which had been pursued to inform that which would be pursued. It involved looking ahead to mentally explore the paths to be pursued to achieve a particular goal.

Reflective Coaching Discourses are generated when solution paths and solutions are not foreseen. The problem serves as a guiding factor in the process (Dewey, 1933). It is a process that involves circularity and reciprocity, where cognitive coaching provides the boundary to allow for the occasioning of this circularity so that the reservoir of one's mental resources will be tapped in a comfortable collaborative atmosphere. It is a process that allows for the "metabolic" perturbations generated within the "membranous boundary" of cognitive coaching. It is a process that is also influenced by elements from the environment. It is a process that conveys thought processes along a path mapped out by the act of mediation instead of being directed. Finally, it is an entity developed within a collaborative networking community where there is mutual enhancement of thinking of all who are involved in the Discourses.

Only as teachers made meaning through reflection were they able to reproduce what they experienced. Therefore, wondering about, internalizing, and questioning their past experiences led to the anticipation of the successful utilization on a larger scale of the knowledge gained during the seminars. The transformation experienced impelled openness and the letting down of their guards as teachers were conveyed during the coaching experience to a desired end.

The circularity and reciprocity inherent in the acts of doing and knowing is stifled in the rigidity of direct teaching which does not bring about knowing by experiencing, but the *Coaching Approach* triggered constant reflection. This provided continuity and led teachers to anticipate the unexpected. Hence, *Reflective Coaching Discourses* emerged in a collaborative, networking community.

The Universality of the Coaching Approach

The *Coaching Approach* is a universal approach that extends the pedagogical horizons of the teaching and learning context. In my study, it facilitated experiences that brought about understanding; because, by experiencing, learners achieved understanding and by understanding they learned. Therefore, they learned through doing and by being actively engaged because it was through being actively engaged in doing that they came to know. It was through being actively engaged in doing that their experiences became significant and meaningful to them. Hence, experiencing is knowing and learning by understanding. Understanding moved them away from a mere knowledge of content to active participation and enabled them to make deductions and draw conclusions.

The *Coaching Approach* is a process that raises one's level of consciousness so that the latent principles embedded in the process are educed by the learner engaged in the process instead of just practicing a set of skills. Thus, this dynamic process led learners to a new level of understanding through the employment of the *tools* of *Cognitive Coaching Discourses* by generating interactive discourses.

The employment of the *tools* was not confined to any particular group but was utilized in the teacher-learning community as well as in the student-learning community, each in a different learning context. The employment of these intellectual *tools* in a collaborative social setting led to the transformation of the discourses and generated the

Coaching Approach that brought about a desired process for learning crucial to learning by understanding. The *Coaching Approach* facilitated learning by understanding because the act of experiencing this process triggered the creative mode of critical thinking that led to mastery and discovery learning (**Finding # 7**).

To learn by understanding, learners had to be led into an experience from which they were able to deduce concepts and processes, an experience that allowed them to look back over the paths taken, to make meaning of the experience, and to project their thoughts ahead. As a result of this reflective experience, learners gained insights about knowing and understanding, and thought processes were further triggered so that the insights gained could be further examined as answers to the why, how, what, when, and where questions were sought. When this was done that which was hidden from view was naturally "uncovered" and brought to light, leading to the moment of the "ah-ha" experience. Thus, the *Coaching Approach* facilitated the development of realizable goals and practical strategies, inculcated critical thinking, and ignited the creative process in individuals as they experienced the cognitive coaching process.

Finding # 7 supports the theory of Structural Cognitive Modifiability (Feuerstein & Feuerstein, 1991), which embraces two major phenomena that are strongly intertwined and unique to human beings: modifiability and diversity. These phenomena, "the propensity of the human being to modify and diversify his cognitive structures throughout the stages of development, are basic to the theory of Structural Cognitive Modifiability" (p. 12). The theory postulates that an important characteristic unique to humanity is flexibility, which renders humankind "capable of modifying and diversifying his cognitive structure in a radical way which will affect his capacity to learn to adapt to more complex and unfamiliar situations"(p.12). Modifiability, Feuerstein and Feuerstein contended, is not contingent only on eco-systems. Neither is "modifiability of cognitive structures of need systems and emotional and attitudinal tendencies" contingent only "on certain environmental, experiential conditions" but "it is also a product of deliberate, volitional decisions which render the activity of the organism and its development largely unpredictable" (p. 13). Thus, "modifiability is directly determined by the quality of interaction between the organism and the environment which becomes possible only by Mediated Learning Experiences" (p. 13).

Mediated Learning Experience "is responsible for the diversification of human cognitive, emotional, and behavioral characteristics" (Feuerstein & Feuerstein, 1991, p. 13) Also, it "produces in the individual the propensities to learn from, and become modified by, these experiences" (p. 13). Hence, direct exposure and Mediated Learning Experiences enable individuals to understand the unique nature of human cognitive structures which are characterized by diversification and modifiability (Feuerstein & Feuerstein). Three parameters or conditions necessary for an interaction to qualify as a Mediated Learning Experience are intentionality and reciprocity, mediation of transcendence, and mediation of meaning. These, according to Feuerstein and Feuerstein, "are considered responsible for what all human beings have in common: structural modifiability" (p.15). These three conditions "are of a universal nature and can be found in all races, cultural entities, and socioeconomic strata" (p. 15). Mediated Learning Experience "is therefore related neither to the language of a particular culture nor to its specific contents but rather to the quality of interaction" (p.17), which may be verbal or non-verbal.

The experiences that brought about learning by understanding, that moved learners away from a mere knowledge of content to active participation, and that enabled them to make deductions and draw conclusions are consistent with the main conditions of Mediated Learning Experiences—intentionality and reciprocity. In Mediated Learning Experiences, "the specific content of the interaction—no matter how important—is shaped by the intention to mediate to the mediatee, not only the particular stimuli, activity, or relationship, but also to share this intention with the mediatee" while "reciprocity is a way to turn an implicit intention into an explicit, volitional, and conscious act" (Feuerstein & Feuerstein, 1991, p. 17). Thus, "the particular event is transformed . . . by the mediator's intention to make it experienced (not only incidentally registered)" (p. 17) and by having it modified to ensure that it is observed and perceived by the mediatee. This experience required "the shaping of the total environment and the 'happening' as [a way of] provoking mediation and offering it in a way that will permit a high level of cognitive, self-reflective, insightful processing" (p. 19).

Hence, the occasioning of the experiences was transformed by my intent to move away from the didactic mode of instruction and to lead learners into the act of experiencing. The implicit intent I had for the occasioning of these experiences was made explicit by the learners as they deduced the goals and principles of the activities and drew the necessary conclusions from their experiences in the activities provided, therefore achieving reciprocity. The mediation of my intent also transformed all that was involved in this context: the mediator, the mediatees, and the activities. Because of the indirect approach—the intention to mediate—the states of mind of the mediator and the mediatees were transformed as the conditions were created to raise the mediatees' level of consciousness. This process affected their thinking and so they were immersed into a state in which they were always thinking about their thinking **(Finding # 10)**. The employment of the *tools* facilitated this process.

Finding # 7 also supports Feuerstein and Feuerstein's (1991) position that:

> The reciprocity of the relationship is manifested by the mutual questioning and answering which shape the . . . dialogic interaction (p.19). . . . It leads to the development of higher mental processes and the widening of the spheres of emotional experiences . . . and creates in the mediatee an awareness of the learning process and the didactic principles underlying it. . . . This orientation, once internalized, becomes the steering power towards more efficient learning. (Feuerstein & Feuerstein,1991, p. 20)

Feuerstein and Feuerstein (1991) consider going beyond the immediate goals of an interaction —the mediation of transcendence—to be the most important characteristic of Mediated Learning Experiences because it can be found in any form of human interaction from the most elementary to the most complex and advanced. This interaction transcends "the act of 'feeding'" to create "an orientation towards 'knowing-understanding.' Thus, both knowing and understanding become crucial needs and eventually powerful determinants of human modifiability" (p. 22). The immediate goal of the interaction is transformed by enlarging its scope to include more remote and important goals, and may even change the means used to achieve the goals (Feuerstein & Feuerstein).

Driven by the intent to transcend, the Mediated Learning Experiences "mediate to the mediatee the meaning of the interaction, its significance, its 'whys' and its 'what for,' and render explicit the implicit reasons for the changes produced for the primary and secondary goals of the interaction" (Feuerstein & Feuerstein, 1991). Consequently, the mediatee is endowed with a need to search for meaning and significance utilizing the energetic and dynamic dimension of the interaction. Doing so, promoted thinking and metacognition.

Finding # 7 also serves to reinforce Dewey's (1933) statement that thinking begins in what may be termed a "forked-road situation" (p. 14), a situation that presents a dilemma or proposes alternatives, a situation that demands a solution and presents perplexity, which "is the guiding factor in the entire process of reflection" (p. 14). Also, according to Dewey (1933), the uncertainty presented by a particular situation is also the beginning of reflective thinking, because "reflective thinking involves a look into the future, a forecast, an anticipation, or a prediction" (p. 117). Thus, discovery and mastery learning took place not as a result of trying to "digest" or regurgitate that which was devolved to the individuals involved, but by mentally examining, exploring, and verbalizing ideas and mediating for meaning in an interactive social setting.

For discovery learning to take place, it seemed both natural and necessary for speech to accompany action during problem-solving activities (Vygotsky,1978). Vygotsky also stated that he and his collaborators "found that speech not only accompanies practical activity but also plays a specific role in carrying it out" (p.25). Therefore, "the unity of perception, speech, and action, which ultimately produces internalization of the visual field constitutes the central subject matter for any analysis of the origin of uniquely human forms of behavior" (Vygotsky, p.26). Speech therefore plays a key role in any learning experience. Vygotsky also stated that "the more complex the action demanded by the situation and the less direct its solution, the greater the importance played by speech in the operation as a whole" (p. 25 - 26). Therefore, when learners are learning new concepts if they are provided with opportunities to employ the principle of talking aloud, explaining, and voicing their thoughts as they occurred then they might be able to retrieve personal experiences and other related knowledge content from the "warehouse of their minds" and connect them to new information in a way that is meaningful to them so that they will remember. Hence, they would be making meaning of the new concepts and they would be able to connect and apply them to various situations and improve their knowledge of subject matter content. Also, as learners are involved in the communication processes most likely they will be able to internalize concepts and skills, improve their language, and engage in reflective thinking. For this kind of reflective thinking to take place, in which thoughts and ideas could be verbalized and meaning and intents were sought, discourse was necessary and the atmosphere had to be conducive because it was not by listening to the explanation of others that learners skills and knowledge were enhanced. It was by being personally engaged. Hence, the *Coaching Approach* encouraged a non-judgmental atmosphere, freedom of expression, and effective communication through the removal of positive and negative verbal and non-verbal evaluative messages from discourses **(Finding # 8)**.

Praise and other positive judgmental messages do not enhance thinking. They might serve to boost the ego, enhance self-concept and self-confidence, and serve to energize recipients to be resilient and to strive to develop their craftsmanship, but they do not generate thinking. Therefore, the minimal use of positive messages and the non-use of the negative creates the setting for discourses to be generated. The generated discourses set the pace for and encouraged effective communication. As a result, the atmosphere for clear thinking and learning by discovery or by "uncovering" concepts was enhanced by this setting. The *Coaching Approach* therefore promoted learning by discovery as students in their groups with defined roles, discovered/ "uncovered" mathematical concepts and principles for themselves as they recognized their own abilities to solve mathematical problems and became less dependent on the teacher, whose role shifted from the expository mode toward one of a mediator **(Finding # 9)**. Each individual was therefore empowered in this setting.

The Tools for the Coaching Approach to Generate Collaborative Learning

While the traditional didactic mode of instruction has been universally practiced as the chief mode of delivery of instruction, the development of students as thinkers to meet societal demands calls for a move away from this didactic mode of teaching to approaches that address teaching for understanding. When working alone, we are limited by the "blind spots" of our individualism, but when our space is extended to honor the views of others, we are able to view issues from multiple perspectives, perspectives that would never come to mind if we were alone. Hence, we need to work with *tools* that help us generate and share our perceptions to aid in the development of our understanding during thinking and learning in a collaborative setting. These *tools* are not limited to a particular language or culture but transcend the barriers of language and culture because they are universal in nature. As a result, the *tools* of questioning, explaining, and grouping with assigned roles that serve the purpose of mediation are employed in the problem-solving process of the *Coaching Approach* to generate interactive discourses.

To generate interactive discourses in the mathematics classroom, teachers mediated what was mediated to them. For students to be able to develop and enhance their mathematical knowledge, these students had to be given the opportunity to engage in discourses to communicate their mathematical ideas. Hence, teachers had to play a central role in orchestrating the discourses that would contribute to students' understanding of mathematics (NCTM, 1991) by providing them with "opportunities to explain, conjecture, and defend [their] ideas orally . . . [and to] stimulate deeper understandings of concepts and principles" (NCTM, 1989, p.78). In doing so, they engaged the students in interactive discourses which aided "the formation of abstract concepts" because, according Vygotsky (1981b), "for pedagogy, the use of language [has] great significance as a means of directing attention and as an indicator of information of ideas" (p. 229).

Grouping by students' choice provided students with the opportunity for friends to work together, to laugh together, to listen to each other's views, and to be interested in each other to ensure each understood through team-work and co-operation (**Finding #25**). Grouping by students' choice, with the assignment of roles, provided a setting in which each student was active in his or her role and contributed to the solution of mathematical problems through pooling ideas and opinions, motivating each other, communicating better with each other, and helping each other not to approach solutions in a one-track way (**Finding # 26**). Grouping with the assignment of roles provided students with an opportunity to collaborate while solving mathematical problems.

The employment of group roles promoted feelings of equal opportunity and freedom to ask questions, give and accept explanations, talk and share thoughts and ideas so students could give and receive help from peers and build the self-confidence that they had the ability to accomplish mathematical tasks (**Finding # 27,** interdependence builds efficacy). The employment of roles helped students strive for excellence and mastery of the subject and generated a comfortable setting for them to share their views, discuss, agree and disagree; identify and expose their own as well as others' weaknesses and mistakes; strengthen their problems-solving skills to grasp principles and to understand problems and solutions better; and to make mathematics interesting and understandable (**Finding # 28** roles: Craftsmanship).

Employing the roles in the small groups, students generated positive attitudes as they participated, learned to cooperate with one another, got to know and understand each other, and related to and reasoned with each other in a comfortable and friendly environment that made each more self-confident because group members were friendly and understanding even when some did not understand (**Finding # 47**). Employing the roles in small groups, students learned from each other in interesting ways; they were provided with the opportunity to work together and to help each other to work carefully step by step; each was made comfortable to be wrong, as mistakes were identified and suggestions for correction were made by group members while solutions to problems were sought (**Finding # 48**). Employing the roles in small groups, students were made more open-minded towards the solutions to problems as they solicited and shared their ideas, opinions, and methods and ensured that each understood before they moved on; thus, they learned different solution paths for the same problem (**Finding # 49**). Employing the roles in small groups, students had the opportunity to explore each other's thoughts and identify whether solution paths were correct or not. Although each might suggest a different path, when ideas were pooled, each solution was considered. Hence, the various solution paths impacted students' understanding as they learned from each other different ways to solve the same problem (**Finding # 50**). Grouping provided students with an opportunity to learn concepts among themselves and to be able to succeed on tests and assignments when assessed individually (**Finding # 59**).

Students suggested that the employment of roles in small groups helped them to be more disciplined. They could now attempt to solve any problem and, during a test, if time were running out, they could use the shortest method or, if they forgot a particular solution path, they might be able to recall another to solve a given problem (**Finding # 51**). The employment of small group roles also ameliorated negative feelings and difficulties experienced when working alone and might have had long-term implications for learning to work collaboratively in the workplace and at higher institutions of learning (**Finding # 52**).

Grouping with the assignment of roles encouraged discourse. It empowered students. This empowerment transcended barriers and aided them in overcoming difficulties. It created a comfortable atmosphere for thinking and learning. The difficulties students faced while working in the individualized setting of the traditional mode of instruction in the classroom were overcome as a result of their group empowerment with the *tools* for the generation of discourses. With the application of these *tools*, a new setting for learning was created through discourses. Through discourses, the individualized worlds came together and were linked together to form a collaborative setting marked by social acceptance (Cragan & Wright, 1999).

This collaborative setting was generated by the use of roles that empowered each individual with the *tools* of questioning and by providing explanations to further generate the interactive discourses. Interactive discourses, Riley (1985) emphasized, must be described in terms of their interactive structure, in terms of the role of the role or the status of the role. These interactive discourses or external social dialogues, according to Wertsch (1980), provide the initial point of entry into the process of learning and provided the "means of directing attention" and stimulating the "formation of new ideas" so that "what is perceived becomes an indicator for other perceived or non-perceived phenomena (Vygotsky 1981b, p. 228). The triggering of ideas and thoughts among group members came through setting in motion and activating "old conditioned connections and new processes of abstraction" (p.226). By engaging in these social dialogues, learners began to pose questions and responses to themselves. They realized that they possessed the ability to solve problems without being dependent on the teacher.

The *Coaching Approach* promoted learning by discovery as students in their groups with defined roles, discovered/ "uncovered" mathematical concepts and principles for themselves as they recognized their own abilities to solve mathematical problems and became less dependent on the teacher, whose role shifted from the expository mode toward one of a mediator (**Finding # 9**). **Findings # 9, 14, 51, 52, 58, and 59** serve to support Vygotsky's (1981a) premise that "all higher mental functions are internalized social functions" (p. 146). Hence, as they recognized their mastery of the concepts and processes they acquired by working collaboratively, they also recognized their inherent abilities to solve problems on an individual basis as they used these techniques by themselves.

The interactive discourses are taken over by students and internalized because "everything that is internal to higher mental functions [metacognition] was at one time external" and was "at some earlier time [based on] actual relations among people . . . just as verbal thought is the transferal of speech to the internal level, and just as reflection is the transferal of argumentation to an internal level" (Vygotsky, 1981a, p. 158). Therefore, what it was for others it is now for oneself because "any higher mental function was external because it was social at some point before becoming an internal, truly mental function" (p. 162). Vygotsky maintained that "first it appears on the social plane, and then on the psychological plane. First it appears between people as an interpsychological category, and then within the child as an intrapsychological category. This is equally true with regard to . . . the formation of concepts" (p. 163).

The aforementioned findings support Vygotsky's (1978) claim that learning creates a zone of proximal development wherein a variety of internal development processes "are able to operate only when the child is interacting with people in his environment and in cooperation with his peers. Once these processes are internalized, they become part of the child's independent development achievement" (p.90). Thus, the learners' zone of proximal development is bridged not through a steady accretion of knowledge but through problem solving "in collaboration with more capable peers" (Vygotsky, p. 86). What a child can do while working collaboratively with others, he or she will be able to do by himself or herself at a later date (Vygotsky).

As a result of the structure for interactive discourses that the employment of the roles promoted, students were empowered to take charge of their own learning. The role of the teacher, as manifested in the traditional instructional setting, shifted to one in which teachers facilitated students' collaborative learning. According to Riley (1985), the most important challenge in discourse management is to "try wrest the control of the discourse away from the teacher" (p. 46). This control was removed through the engagement of students in their assigned roles to form a collaborative setting for learning by generating discourses that enhanced learning and eliminated isolation and provided students direct experiences to engage in problem-solving.

To interpret a problem is to make meaning of it. To make meaning is also to interpret an experience. An experience may be generated through the use of the *tool* of questioning. To make meaning, a questioning technique was used that impelled thinking, generated probes, and incorporated wait-time that allowed enough time for reflection and processing of information and signaled respect and faith in the person's ability to respond effectively to the cognitive tasks at hand, and served as an alternative to "telling" in the teaching and learning context (**Finding # 15**). The mediation of meaning was achieved by the use of the *tool* of questioning that generated thinking, enhanced cognition, and promoted metacognition on the teacher-level as well as the student level. Empowered with the *tool* to think, students strove to develop their craftsmanship. The questioning helped them improve their understanding and performance by allowing them to have open minds and by providing them opportunities to recognize errors, seek clarification, investigate, invent their own methods of solution, and provide explanations for problems, for solutions, and for decisions made (**Finding # 30:**).

Empowered with the responsibility to ask questions in the group-setting, students no longer experienced the frustration they had while working alone, but were able to draw from one another's past experiences and previous knowledge to solve mathematical problems. That which they learnt in the group-setting, they practiced on their own to enhance their understanding of concepts (**Finding # 58**). Questioning and explaining in student small groups enhanced understanding and clarification of concepts and encouraged open-mindedness, sharing, and the exploration of alternative methods of finding solutions or the combination of suggestions to produce solution paths (**Finding # 61**). Being initiated to questioning in the small groups seemed mechanical at first for some students, but they were provided with the opportunity in their groups to express their views, to listen to each other, to pool their ideas, and to ask why, how, etc. when errors were identified and when clarification was needed to ensure understanding (**Finding # 45**). The pathway of communication, with questioning as the starting point, established the circularity and reciprocity embedded in the connection between action and experience as the *tools* were employed and as alternative solution paths to a problem were shared (**Finding # 62**).

The questioning technique served as an alternative to telling. It also served the purpose of mediation. Hence, **Findings # 15 and 30** support Feuerstein and Feuerstein's (1991) claim for the mediation of meaning, which was employed so that an interaction could be generated to bring about responses to questions that elicited when, where, what, how much, by whom, why, etc. To understand the meaning of an action, statement, or even a question, teachers had to employ the *tool* so that it could be used as a means to generate thinking in their students instead of telling the students directly what to do and how to do it. Through this indirect means, students were "forced" to think about what the teacher was trying to convey to them. They, in turn, had to use the same tool to clarify their thinking by questioning the teacher and by exploring one another's thoughts for meanings and intents as they engaged in the solution of problems in the group setting. The mathematical problems posed presented a feeling of perplexity because the teacher did not provide a way to solve them as in the traditional setting.

Findings #30, 58, and 61 are also consistent with Davis' (1984) postulate "that new knowledge representation structures are ordinarily created by combining, modifying, and extending previously created structures" (p. 358). Davis further explained that "you can only find things in memory when some kind of search mechanism or strategy or accident leads you to them" (p. 359). This strategy or mechanism, as the foregoing findings reveal, is the *tool* of questioning. The questioning served to enhance students' understanding as they sought elaborations to their thoughts; thus, their previous knowledge was modified as the gaps were filled and additional information was supplied to extend previously learnt constructs.

Students also re-attended their past experiences, drew from one another ideas relevant to the occasion, and pooled them towards the solution to the problems. As a result, the frustration experienced while working alone disappeared and the questioning in the group setting helped students internalize concepts. The questioning technique also served as cues to retrieve information from the vast information store-house of the brain to process it in the small work-space of the brain (Davis, 1984) and to allow for the connection of pieces of mathematical knowledge which were meaningless by themselves. Hence, the circularity and reciprocity inherent in this setting, prompted by the questioning techniques, served as the starting point for the generation of *Reflective Coaching Discourses* that encouraged thinking and reflection in the small group setting.

Explaining aids understanding and performance by providing opportunities for students to communicate and comprehend what was not understood, to clarify misconceptions, to grasp concepts better, to enhance communication, and to overcome weaknesses and the tendency to make mistakes (**Finding # 31** Explaining: craftsmanship). Explanations presented different levels of thinking that aided understanding and helped individuals who were explaining their ideas to gain a clearer understanding as their thoughts and ideas were verbalized (**Finding # 32**). Paraphrasing is listening intentionally and communicating what is understood. It serves the purpose of validation and clarification and leads to the next question (**Finding # 16**). Explanations in the small groups enhanced understanding of what was being explained; also, as ideas were verbalized, understanding was enhanced; recall of previously learnt concepts took place and a better understanding of those concepts was also achieved (**Finding # 46**).

The important role of verbalizing perceptions while engaging in the solution of the problems aided students' understanding of the problem, the planning of the solution to the problem, and the carrying out of the solution to the problem. As students stated, by being given this opportunity to verbalize their ideas, they understood the concepts more clearly as they engaged in the act of verbalizing (**Finding # 31, 32, and 46**). Only through the expression of the thoughts was others in the group able to recognize the similarities and differences in the thoughts and able to explore the differences. Only in the expression of the thoughts was the need for clarity and elaboration recognized and addressed so that that which was recondite could be made obvious. Explaining aided understanding as it provided the means by which that which was understood or misunderstood was communicated. As a result, conceptions and misconceptions were clarified as they were verbalized. Explaining also generated different levels of thinking which were analyzed as solutions to problems were explored. When all individuals in a non-competitive group worked on the same problem, each was allowed to explore a particular solution path unique to the history of his or her mathematical experiences.

With students gaining the necessary understanding to solve problems through the use of these tools, many were able to internalize these processes and on their own were able to do what they had done while in the group setting. **Findings # 30** and **51** further support Vygotsky's (1978) claim that "what is in the zone of proximal development today will be the actual developmental level tomorrow—that is what a child can do with assistance today [he or] she will be able to do by [himself or] herself tomorrow" (p. 87)

Without questions there would be no explanations, neither would there be inventions. So for the *Reflective Coaching Discourses* to be ongoing and interactive, questioning provided the boundary within which to navigate as learners' consciousnesses were raised. As students engaged in *Reflective Coaching Discourses,* they either examined relationships between and among the expressed ideas and often combined them to create their own solution procedure to problems or developed each to form alternative modes of solutions. As students engaged in checking and re-examining, seeking to know how, why, where, and when certain knowledge could be used, they were engaging in metacognition (Garofalo & Lester, 1985). Hence, I believe the *Coaching Approach* is universal and transcends the borders of a particular learning group by the employment of the communication *tools* that generate discourses.

Eliminating Teacher Isolation

The traditional setting of the teaching and learning context which existed for the mathematics teachers in the participating school before embarking on this study encouraged teacher isolation. Opportunities to talk and share pedagogical issues existed at a minimal level. The usual judgmental stance which existed in this setting created further barriers. Whatever was said was evaluated, and often the intent was lost because of the judgments made. This isolation limited teachers' development and creativity and inhibited exploration in the teaching and learning context. Teachers functioned as "islands" because they feared being perceived in a negative way, of not wanting to be criticized, of not wanting errors and mistakes to be highlighted, and of not wanting their words and actions to be evaluated. The highlighting of the negatives crushed egos and caused withdrawal. The traditional setting also perpetuated the superior/inferior, novice/expert relationships, and negative judgments led to separation and categorization.

However, when opportunities for sharing and working together in a relaxed atmosphere were created during the seminar setting, the whole-group sharing sessions, and coaching sessions, barriers were broken down as individuals began to talk and to share. That is, they collaborated in a structured manner. As they collaborated, they realized that they had much in common. Their struggles, needs, and goals for teaching and learning were similar. They recognized common grounds they could work on. Sharing and working together, they realized that each could make vital contributions to enhance one another's learning even though each person was different. Although they approached things differently, they realized that they could arrive at the same end. They recognized that the way each person does things was not only different but unique. They also recognized styles, principles, skills, and content knowledge that were displayed by the others and that they could also embrace. They found that they could work together on anything. They realized that while they were being helped, they were also helping others. They realized that, this process involved a two-way relationship, an interdependent relationship in which each person functioned as a whole and also as a part of a larger community with each affecting the other in a positive way. Hence, the *Coaching Approach* helped eliminate teacher isolation through collaboration in a structured form, transformed relationships by generating better understanding between and among teachers, and enhanced teachers' states of mind as the opportunities to share as a group and to coach one another promoted team work (**Finding # 10**).

The Professional Development Process as an integral part of the *Coaching Approach* provided teachers with the opportunity to share. The opportunity to participate in the conferencing cycles and teacher whole-group sharing sessions maximized teacher collaboration and on-going professional development. **Finding # 10** supports Costa and Garmston's (1994) position that cognitive coaching—the third type of clinical supervision—emphasizes collegiality because of the move that is made from the supervision model in which supervisors assume the expert/superior modes and in which teachers take on the novice/subordinate modes as they are told what to do and how to do what is to be done. The emphasis on collegiality in cognitive coaching encouraged a move to a process that aided the cultivation of self-appraisal and self-supervision and built collaborative relationships through a system of effective communication (Costa & Garmston). As individuals worked together, the goals of cognitive coaching were realized as thinking was enhanced, mutual learning was facilitated, and holonomity was achieved. According to Costa and Garmston, "cognitive coaching promotes cohesive school cultures where the norms of experimentation and open, honest communication enable everyone to work in healthy, respectful ways" (p.8). Cognitive coaching also creates the climate, environment, and context which empowered individuals to generate results (Costa & Garmston).

The "states of mind," utilized as *diagnostic tools* by teachers, served as the means to examine both teacher's and students' behaviors during the employment of the alternative approach **(Finding # 38)**. Being empowered with the diagnostic *tools* of *Cognitive Coaching Discourse* during opportunities provided by the structure in the *Coaching Approach*, teachers found that their states of mind were transformed both on the individual level and group level as they worked collegially to enhance each other's professional growth and self-appraisal. **Finding # 10** is also consistent with the results of studies by Edwards, Green, Lyons, Rogers et al. (1998) and Edwards and Newton (1995), which revealed that teachers' efficacy was enhanced by cognitive coaching. Also, in a study by Garmston et al. (1993), Garmston, as coach, could have assumed an expert superior role. Instead, a collegial, consultative role was embraced. Although the consultative arrangement was not reciprocated, embracing this collegial role led to collaborative relationships and facilitated the cognitive development of the persons being coached.

Collaboration through the structure provided by the cognitive coaching relationship built individuals' self-confidence, encouraged thoroughness, transformed individuals, and provided opportunities to work together and to understand each other. It also provided opportunities for them to support each other and contribute to each other's professional development. Collaborating in this manner, teachers realized that they had to embrace a non-judgmental stance that encouraged them to "let down their guard" and to express thoughts and ideas that might not be well framed and developed. It also encouraged open-mindedness and provided an opportunity for everyone to participate in any setting. It generated a professionally caring culture in which each wanted to help the other to become better at something to enhance their pedagogy. Thus, collaboration inherent in the *Coaching Approach* promoted freedom of expression and development of interactive *Discourses* through the generation of a trust-building, secure, and relaxing environment as no value judgments were placed on individuals' ideas; teachers participated and felt safe to express and explore their thoughts and ideas because they were respected and valued (**Finding # 11**). Also, the *Coaching Approach* brought about a transformation from a formal, individualized, and isolated world to one that manifested itself in professional empathy and in the building of trust and empowered teachers to be in command of the teaching and learning context (**Finding # 13**).

Findings # 11 and 13 seemed to provide partial support for one of Greene's (1992) finding for the Medicine Hat School District professional development model. She stated that the model encouraged teachers and administrators to take risks. Classroom intervisitation was a common occurrence as teachers visited each other's classrooms and observed each other's teaching with some observations occurring across schools. She also stated that, in this setting, developing a trusting relationship was a significant step in the professional development process as teachers were willing to become vulnerable, and administrators and teachers became willing to expose and share their teaching with their colleagues. However, she concluded that

> even after three years . . . the content of most conferences and teacher discussions focused primarily on relatively low-level and non-threatening behaviors—

> questioning skills and student on-task behaviors. Only toward the end of the third year did teachers begin to reflect on, analyze, and try to address more complex teaching behaviors and student outcomes. (Greene, 1992, p. 139)

My findings differ on this basis because from the initial stages teachers were invited to generate and develop a setting that was different, a setting that employed *tools* that served to mediate intention, reciprocity, meaning, and transcendence (Feuerstein & Feuerstein, 1991). In this setting, teachers were impelled to metacogitate, to analyze their decisions, actions, feelings, and states of mind. Teachers, from the onset, encouraged reflection/metacognition in all their discourses so that their intent to enhance each other's pedagogy was always mediated. They felt safe to experiment.

Teachers' initiation to the tool of conferencing led to an investigation of how student group-structure could be brought into the classroom-setting; the plans made were effected, and their immediate impact was observed and reflected on, a process which led to the deduction of the difference between the process of evaluation and the process of cognitive coaching (**Finding # 19**). **Finding # 19** supports Costa and Garmston's (1994) position that the primary difference between cognitive coaching and evaluation is that cognitive coaching uses conferencing cycles for the sole purpose of helping teachers improve their instructional effectiveness by helping them to become more reflective about their teaching. **Finding # 19** also supports Costa and Garmston's position that the relationship that is presumed by cognitive coaching is that teaching is a professional act and that coaches support teachers to become more resourceful, informed, and skillful professionals. Also, as a result of the collaborative cognitive coaching process, perceptions are refined and the basic principle of knowledge construction is incorporated. **Finding # 19** also seemed to provide support for Costa and Garmston's finding that the cognitive coaching process provided teachers with the opportunity to talk aloud about their thinking and decisions about teaching. Doing so energizes teachers and influences them to "refine their cognitive maps," their instructional choices, and their actions. Consequently, the collaborative setting promoted by cognitive coaching is one that is action oriented, result oriented, and person oriented as one's mental processes are engaged and transformed.

Finding # 13 also supports Costa and Garmston's (1994) position that one of the strengths of coaches lies in their ability to empathize. Hence, acknowledging feelings, emotional states, representational systems, and cognitive states of others during the coaching process is essential for effective communication and the enhancement of relationships. Being sensitive to these issues, coaches developed their flexibility. Revealing this sensitivity through the expression of empathy also aided in the development of trust. According to Costa and Garmston, "developing trust is knowing how to be flexible with people" (p. 57). Therefore, trust exists when a comfortable atmosphere is generated and when positive feelings of openness and willingness to share are encouraged. On the other hand, trust may be eroded when judgments are made **(Finding # 12)**.

Findings # 11, 12 and **13** support one of the chief realizable goals of cognitive coaching—the establishment and maintenance of trust (Costa & Garmston, 1994). The chief principle in fostering an environment for individuals to express ideas freely to bring about effective communication is trust. Trust had to be established in the process first. The individuals involved also needed to provide the necessary conditions for trust; therefore, trust in the individuals involved was also necessary. The belief in oneself and one's ability to aid in the creation of this environment was also necessary. Therefore, trust thrives on trust to sustain trust. Costa and Garmston acknowledged that one role of coaches is to help to create the setting for experimentation by building trust in four areas: trust in self, trust between individuals, trust in the process involved in cognitive coaching, and trust in the environment (Costa & Garmston).

Findings # 11, 12, and **13** also support da Costa and Riordan's (1997) conclusion from their study which involved teachers in a collaborative process. They stated that teachers had a high degree of confidence in their teaching because they trusted their partners with whom they were willing to experiment and to critically assess innovative techniques in the classroom. They also stated that teachers who were confident in their teaching abilities and who trusted their teaching partners did not perceive a high degree of risk in having their teaching-partners observe their teaching.

Every element in the collaborative setting impacted on trust-building. Trust was essential for effective communication. Because experiencing is understanding and understanding is learning, it was imperative that teachers be led into an experience with the building of trust through the mediation of transcendence. Costa and Garmston (1994) maintained that trust allows individuals to process and make meaning of learning, and so recognizing how one relates to others of similar or dissimilar cognitive styles, knowing how to network, how to draw on the resources of others, and how to value each other's expertise and appreciate differences in view points, perceptions, and knowledge bases are essential for the building of trust. Therefore, as individuals engaged in the structured manner provided by the *Coaching Approach*, communication and trust were enhanced.

"To develop a good relationship trust must be established" (Johnson, 1997, p.73). *Coaching Discourse* which employs the *tools* to mediate intention, transcendence, and meaning (Feuerstein & Feuerstein, 1991) created the setting for the development and establishment of trust. Hence, **Findings # 11, 12 and 13** are consistent with Costa and Garmston's (1994) proposition that, for cognitive coaching to be effective, the coach has to help to create a low-stress environment for teachers. Teachers should feel comfortable in the setting where they "are encouraged to inquire, speculate, construct meanings, self-evaluate, and self-prescribe" (Costa & Garmston, p. 36). They should also feel "comfortable enough to create, experiment, reason, and problem solve" (p. 36). That is, they have to be able to let down their guard and become vulnerable (Johnson, 1997) so that there is openness for "the sharing of information, ideas, thoughts, and reactions to the issues being discussed," along with the offering of resources to others to help them achieve their goals (Johnson, p. 75). The *Coaching Approach* eliminated teacher isolation by creating the setting for openness and trust during the on-going Professional Development Process.

Teacher Collaboration Through Conferencing

Inviting teachers into a collaborative relationship, I led them into an experience in which they saw the need and the reason for collaboration. The benefits of collaboration also had to be perceived by inviting them into an experience which mediated my intents as the immediate goals of the activities were transcended to provoke individuals to deduce the meaning and the desired overall major goals of their experiences. Having created the thirst for such a relationship during the seminars, I helped teachers downplay the passing of judgments both verbally and non-verbally to enhance the building of trust. The barriers that promoted isolation were being removed, and teachers became open and ready as they entered into the second phase of the Professional Development Process, which included conferencing.

Conferencing, as part of the PDP, included three phases: the planning conference, the lesson observation, and the reflecting conference. As a coach/mediator or co-coach, my role was collaborative consultative (da Costa, 1995), predicated on mutual trust and respect. This role provided teachers with extra support and helped them see beyond the immediate implications of the particular actions that were elicited. This role was necessary as a supporting role for teachers to become confident in their roles as coaches and coachee as they sought assurance about their roles ensuring that the paths they were undertaking were the correct ones. My supportive role also served to move teachers beyond the mechanics of the experience and emersed them into a state of reflective thinking/metacognition where they would assess the process they were involved in, the thoughts, ideas and actions that were brought to bear upon their experiences to make meaning of their experiences through their own interpretations. On the other hand, teachers coached their coaching partners, mediating what they knew as a result of what they experienced in the process. Teachers coaching teachers served to mediate and reinforce the principles they were accommodating in their own teaching and learning context. Therefore, while learning through experiencing, they were helping others engage in a similar experience through mediation.

As the territory for the conferencing was mapped out by questioning, the planning conference "forced" the sequencing of concepts and activities, led to thorough preparation, served to clarify details, and helped all teachers to know exactly what they were going into the classroom to "teach" **(Finding # 34).** Attending only one day of the June seminars, Mrs. Jacobson was not exposed to the processes involved in the use of some of the *tools*; however, being exposed to the tool of conferencing impacted the preparation of her lessons (**Finding # 53**). The planning conference discourse also helped teachers mentally rehearse what they had planned, raised their consciousness to the possible situations that might occur in the particular context, and generated a level of confidence and awareness and encouraged flexibility (**Finding # 42**). The planning conference also enhanced conceptualization of mathematical concepts that teachers wished to invite students to learn; it encouraged flexibility and openness to the various solution paths that students might take, and encouraged teachers to become aware of alternative strategies they might want to suggest that students could take to arrive at solutions to problems (**Finding # 60**).

As the planning conference raised their consciousness, teachers sought various means to develop their craftsmanship, whether by consulting fellow teachers about concepts they were not very clear on, by going to textbooks to ensure thorough understanding, or by engaging in reflective thinking about past teaching experiences. It immersed them into a situation in which they were always thinking about what they would be doing in the classroom. They were always examining their mathematical histories for gaps in their conceptions and their need for elaborations or re-examination of conceptual understanding. The planning conference provided a mental preparedness that would not have otherwise existed. Being invited to be always thinking of alternatives enhanced teachers' flexibility as they thought about the various possibilities for a particular approach and the possibilities that students could come up with. By becoming aware of the various possibilities they could come up with and by always thinking about those possibilities, teachers generated further possibilities with respect to those possibilities. As a result, teachers were always reflecting on their actions and on ideas, their confidence and flexibility were enhanced, and the urge to try out alternate ideas as they were generated was accommodated by the planning conferences.

The degree of flexibility and mode of experimentation, as revealed by the data were different for all teachers. **Findings # 34, 42, 53, and 60** support Costa and Garmston's (1994) view of the planning conference. Costa and Garmston stated that conferencing provides the structure that helps teachers master their subject matter in advance. Also, the structure of the planning conference provides detailed mental rehearsal of the lesson that has been prepared as strategies are refined and potential flaws in lessons are identified. They further stated that the process also engages the teacher in the role of an experimenter and aids in the anticipation of possible events and consequences relating to students' behaviors.

Findings # 34, 42, 53, and **60** are also consistent with Dewey's (1933) position that, to provide the kind of learning context for students where learning is maximized, teachers' "intellectual preparation in subject matter" is crucial (Dewey, p. 274). This preparation, according to Dewey, "should be abundant to the point of overflow. It must be wider than the ground laid out in textbooks or in any fixed plan for teaching a lesson. It must cover collateral points, so that the teacher can take advantage of unexpected questions or unanticipated incidents." Because, "unless the teacher's mind has mastered the subject matter in advance, unless it is thoroughly at home in it, using it unconsciously without the need of express thought, he will not be free to give full time and attention to observation and interpretation of the pupil's intellectual reactions" (Dewey, p. 275). Therefore, the possibilities that might have been generated in the learning context were given consideration as a result of planning for the particular lessons leading to teacher flexibility and the flexibility of the approach.

The flexibility of the approach allowed teachers to experiment and translate into the classroom context what was significant in their learning experiences from the PDP. As the data revealed, each teacher's mode of experimentation was different. Mrs. Jacobson experimented with groups of two in comparison with the groups of three that the *Coaching Approach* recommends. So initiating her students to the alternative approach using groups of three, Mrs. Jacobson observed the effect on the students' behaviors, continued its use with the particular class, introduced it to her other classes, and sought adaptations but reverted to the original model which she considered more effective (**Finding # 55**).

Mrs. Sinclair experimented with the whole-class initiation to the discourse-oriented learning for students with the objective of empowering students in their roles to enhance their learning and to enhance her own teaching. Using Mrs. Sinclair's terminology for the mediatory kinds of questions—"coach"—Mrs. Sinclair encouraged the students to coach her during the lesson in the large-class setting. Consequently, the students were initiated into the kinds of questions they should ask one another in their small-group setting (**Finding # 35**). As a result, students' "coaching" Mrs. Sinclair served to empower her. Anticipating the students' questions, she sought various means to conceptualize the concepts she was inviting the students to learn (**Finding # 36**). Being initiated into the alternative approach, Mrs. Sinclair's students, in their small groups, were able to "uncover" mathematical concepts, leading them away from mechanical learning to conceptual understanding (**Finding # 37**).

Mr. Lennox also experimented with the whole-class discourse-oriented classroom, empowering himself with the mediatory questioning technique. This seemed only a step away from the traditional mode of instruction, and it appeared as if he were hesitant to release the students totally to think for themselves. However, he provided them with "windows" of opportunities to work in small groups and saw that this alternative approach empowered them in their roles, enhanced their confidence level, and gave them the opportunity to contribute and to share ideas with one another, while respecting one another's opinion, encouraging one another to make suggestions for solutions to problems, and ensuring that each understood the concepts to be learnt (**Finding # 44**).

The reflecting conferences achieved the same objectives as the planning conferences. They promoted thinking. They also promoted thinking about thinking and the implications of certain actions. They provided the avenues for cognition and metacognition. For example, during the reflecting conference discourse, Mr. Lennox reinforced his belief that the pre-conference discourse prepared him for the unexpected. It had already raised his consciousness about the various possibilities that might occur in the classroom because he always had to be thinking of alternatives. As a result, he was impelled to be flexible and was able to think on his feet and to deal with any turn of events because he was developing a level of tolerance and learning not to be judgmental (**Finding # 43**). For Mrs. Jacobson, the reflecting conference discourses provided opportunities for her to become aware of and to reflect on her rigidity in the teaching and learning context and her unwillingness to release her students to think for themselves

(Finding # 54). Also, the reflecting conference gave teachers the opportunity to use the "states of mind" as *diagnostic tools* to examine both their behaviors as well as those of their students during the employment of the alternative approach **(Finding # 38).**

Conferencing as a *tool* for cognition, according to Costa and Garmston (1994), "engages, causes awareness of, develops, labels, and enhances" (p. 107) the intellectual functions of the mediatee or coachee. With the mediatees' becoming aware of their states of mind by examining their actions, statements, or decisions and the premises upon which these might be based, they were engaged in the act of reflection. Reflection, according to Dewey (1933), is the "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends" (p.9). Mezirow (1991), elaborating on Dewey's definition, stated: "reflection is critically assessing the content, process, or premise(s) of our efforts to interpret and give meaning to an experience" (p.104). Utilizing the *diagnostic tools*, teachers engaged in self-reflection as they examined their actions and interpreted them to enhance growth in the five states of mind. They also self-prescribed as they suggested alternative decisions or actions they could have made and also suggested these as future paths they could take if faced with similar situations.

According to Costa & Garmston (1994), the reflecting conference encourages self-reflection as the coach invites the coachee to reflect on what has been learnt from the coaching experience and to suggest refinements or changes to the process. The coachee is also encouraged to identify how "new learnings, discoveries, and insights" (p. 22) will serve to inform future lessons. This projection is consistent with Dewey's (1933) premise that "every complete act of reflective inquiry makes provision for experimentation –for testing suggested and accepted principles by employing them for the active construction of new cases, in which new qualities emerge" (Dewey, p. 188).

Conferencing also served as the means to enhance pedagogy, including exploring the realm of teaching and learning and learning from decisions taken and actions performed whether they were negative or positive. The latitude for experimentation that this approach promoted speaks to the flexibility of the approach and also the enhancement of the states of mind for each teacher as each was moved from a degree of rigidity to embrace a greater measure of flexibility, as revealed by the data.

Translating the PDP Experiences to Generate Student Collaboration Through the Mathematics Learning Experiences (MLE)

Communicating my intent to the teachers about the PDP that they would be involved in, and employing the mediation of intention (Feuerstein & Feuerstein, 1991), I expressed my intent that teachers generate a similar set of learning experiences to those they would have during the PDP. Then I invited them to participate in a series of activities during the Professional Development Process. During the PDP, I employed mediation of transcendence by helping teachers move beyond the immediate goals of the series of activities, which appeared to have no relevance to the teaching and learning of mathematics, to deduce the significance of each of their experiences by understanding the why's and wherefore's and to make meaning of each experience as it related to the teaching and learning context. Hence, teachers made meaning of their experiences and were able to qualify the experiences and to generate similar ones with their students. This learning experience for teachers transcended the act of dispensing information to create, according to Feuerstein and Feuerstein, an orientation towards knowing and understanding.

As a result of the formal application of the *tools* to generate an experience for teachers that dealt not only with the immediate principles and techniques of the cognitive coaching experience but that transcended the borders of cognitive coaching to generate a similar learning experience for students, teachers internalized these *tools* and considered them as the main pillars of their own experiences upon which the climate and culture for collaborative learning among students should be built. The trust-building *tools* of *Cognitive Coaching Discourses* included grouping of teachers in the collaborative setting with the assignment of specific roles, techniques in questioning including wait-time, paraphrasing and probing, and appropriate body language. These were considered important cornerstones of the MLP because they generated trust, rapport, and effective interactive discourses in the teaching and learning context (**Finding # 17**).

Deducing these *tools* as foundational pillars for the learning experiences of their students, teachers had to be engaged in thinking. As I engaged teachers in recalling, analyzing, and assessing their experiences, they were able to make meaning of these experiences by providing interpretations. They noted that student collaboration through grouping, with each individual assigned a specific role, allowed for the sharing of different perspectives toward the solution of problems, led to an increase in the utilization of the knowledge and skills each person brought to the learning situation, served as a basis for building trust, and freed teachers from the act of lecturing (**Finding # 14**). Looking back at these experiences and impressions and recalling specific information, they were able to identify relationships, to make connections, and to give meaning to their experiences as they deduced the how, what, when, and why of that which they experienced and projected their thoughts towards the teaching and learning context of the mathematics classroom. They were engaged in the act of thinking, which included operations designed to make meaning (cognitive operations) combined with those that direct how meaning was produced (metacognitive operations) (Beyer, 1987).

According to Beyer (1987), "the goal of cognition is meaning-making" (p.22). My intent to invite teachers into this kind of experience was to help them make meaning of their experiences by engaging them in thinking and helping them to think about their thinking. Beyer noted that "The environment in which thinking occurs shapes thinking" (p. 20). As a result of the engagement of teachers in discourses between and among themselves, the kind of thinking that occurred involved the use of previous knowledge, one or more cognitive operations, and attitudes or dispositions that differed from those that would have occurred if teachers had been engaged in reflective thinking alone by themselves (Beyer). Teachers brought their personal histories into the context as a result of the interactive discourses.

Beyer affirmed that "thinking involves two kinds of operations, cognitive and metacognitive" (p.22). Cognitive operations generate meaning and include "complex strategies, such as decision making, problem solving or conceptualizing as well as . . . less complex processing skills such as analyzing and synthesizing, reasoning skills and critical thinking skills such as distinguishing the relevant from the irrelevant" (p. 17).

Metacognition, on the other hand, "consists . . . of those operations involved in directing one's efforts to find or make meaning, especially the major operations of planning, monitoring, and assessing one's thinking (p. 17). Engaged in what I envisioned as the spiral effect involved in thinking, teachers started their thinking processes at the basic point of recalling the events of the various activities and engaging in the various operations to produce the meaning of their experiences.

Leading teachers in this spiral mode of thinking, I used mediation instead of training or a direct mode of instruction. In the training model, learners are not thinkers but acceptors or conformers, totally dependent on the "expert" from whom they will get the particular information. The expert has the information and the "novices"—the learners—might be allowed to perform a task based on the information the expert possesses and is trying to transfer to the learners. Hence, the novices/learners are totally dependent upon the expert to monitor the task being performed because they do not possess the knowledge to evaluate their own performance. However, learners can gradually gain knowledge as they perform tasks and are able to deduce for themselves (with the passing of time) that it was a particular bit of content the task performed was evaluated for. If the learners are not able to make deductions for themselves, then they remain a "slave" to the expert to tell them what is wrong or right with the task performed. Hence, it takes a long time for the learners to gain the total picture because information is presented like the process involved in using building blocks to build a wall.

My interpretation of the training model is supported by the model used for reciprocal teaching (Palincsar & Brown, 1984). Palincsar and Brown stated that in reciprocal teaching

> First, an expert . . . guides the child's activity, doing most of the cognitive work herself. The child participates first as a spectator, then as a novice responsible for very little of the actual work. As the child becomes more experienced and capable of performing more complex aspects of the task, aspects that she has seen modeled by adults time and time again, the adult gradually cedes her greater responsible. The adult and child come to share the cognitive work, with the child taking initiative and the adult correcting and guiding where she falters. Finally, the adult allows the child to take over the major thinking role and adopts the stance of a supportive and sympathetic audience. (Palincsar & Brown, p. 123)

As explained here, we see that the learner is not engaged in thinking but in a process where information is metaphorically poured slowly from the jug (the expert) into the mug (the mind of the learner). This expert scaffolding is consistent with Vygotsky's (1978) explanation for the process of internalization in very young children as part of their developmental process:

> The transformation of an interpersonal process into an intrapersonal one is the result of a long series of developmental events. The process being transformed continues to exist and to change as an external form of activity for a long time before definitely turning inward. (p. 57)

However, if this position advocated by Vygotsky (1978) in the development theory for internalization is used to explain the process of internalization that takes place in learners then I cannot accept it. Because it robs the individual learners of thinking operations, knowledge, and dispositions unique to their personal histories that are integral to learning and that they might bring to the learning context. But the mediation of transcendence, intentionality, and meaning (Feuerstein & Feuerstein, 1991) incorporates the process involved in learning that takes place best in the collaborative social setting (Vygotsky, 1978; Bruffee, 1993).

The important role attributed to the social context, as advocated by Vygotsky (1978), is integral to collaborative learning. Bruffee (1993) maintained that collaborative learning takes place among persons; it is a social process. In the social setting, when individuals come together, no two individuals might know the same thing in exactly the same way. Some individuals might understand a particular concept to a certain point, but are not able on their own to move beyond that point. Others might have a more elaborate understanding of the particular concept or process and might be able to supply the missing information and processes. Since the gaps in one individual's knowledge might not be common to the other, as individuals come together to share, the gaps in their knowledge are filled by the other individuals' sharing of their knowledge. This "gap" or "gray area" in one's understanding is referred to by Vygotsky as the "zone of proximal development."

The zone of proximal development, according to Vygotsky (1978), "is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Hence, one's "zone of proximal development today will be the actual developmental level tomorrow" (p. 87) because "what a child can do with assistance today [he or] she will be able to do by [himself or] herself tomorrow" (p. 87). As a result of the heterogeneous nature of the group involved in collaborative learning, different experiences, talents, and abilities are included and the individuals' zone of proximal development overlap (Bruffee, 1993). That which is missing is supplied by peers and not necessarily by experts. The roles effected in students' small-groups and conferencing between teachers support this premise.

Having been engaged in collaborative learning and experiencing this learning process as a group during the seminars—the first stage of the PDP—teachers began independently to examine the extent to which they had accommodated the *tools* they experienced. Before beginning their translation in the classroom setting, the time between the series of seminars provided teachers with the opportunity to begin to employ in an informal setting some of the *tools* that they were exposed to during the seminars, to begin to recognize their weaknesses in the communication process, and to begin to remedy these weaknesses (**Finding # 18**).

After the independent informal use of the tools, teachers embarked on an individual translation of their experiences. Mrs. Scott, embarking on the translation of her experiences in her classes, generated the *mathematics learning experiences* (MLE) with her 4—Arts Girls. She experimented with the *tool* of grouping with assigned roles; students in their groups functioned as a unit and exhibited a marked change in their attitude to mathematics and were learning more, discovering more, practicing more, and understanding more and at a faster rate (**Finding # 20**). Her role changed from that of a lecturer to that of a coach as she engaged students in the collaborative learning setting. She was also making her own applications of the coaching techniques for the students' *mathematics learning experiences*. Hence, the *Coaching Approach* seemed to be reciprocal and circular in nature. As the teacher questioned the students in their groups, the students in return questioned the teacher and questioned one another within their groups (**Finding # 21**). The dynamic process of the interactive nature involved in mediation is one that is continuous, producing the ripple effect. It creates in the individual the propensity to mediate naturally in every situation.

Making her own applications of her experiences in the classroom, Mrs. Scott engaged the students in an experience similar to the one she experienced during the PDP. Therefore, the reciprocity inherent in this approach generated a similar approach for the teaching and learning of mathematics—the *Mediated Discovery Approach*. The *Mediatory Discovery Approach* is the process by which learners in small groups with assigned roles employed mediatory *tools* to draw from and to pool their experiences so as to explore or exhaust the "couplings" of their thoughts and ideas to solve problems on their own (**Finding # 22**). **Finding # 22** supports Polya's (1973) premise that

> there is a grain of discovery in the solution of any problem. Your problem may be modest; but if it challenges your curiosity and brings into play your inventive faculties, and if you solve it by your own means, you may experience the tension and enjoy the triumph of discovery. (Polya, p. v)

Thus, students employing the *tools* of *Coaching Discourse* challenged the capacities of one another. Independent thoughts, concepts, and ideas were allowed to come together so that, on their own, students could bring forth a solution and experience the fruits of their mental explorations. They gained experience in the process involved in mediated discovery. As a result of the creation of this setting—a discourse-oriented setting—students' curiosities were challenged; their intellectual development was not hampered, and they were provided with the means of, and the taste for, independent thinking (Polya, 1973). Polya maintained that a student, if left alone to solve a problem without any help or with insufficient help, might not be able to make any progress. However, students can be helped effectively, yet unobtrusively and naturally, if they are asked questions that aid their understanding of the problem, that helped them to devise a plan and to carry out the plan for the solution, and that will aid them to look back at the solution process.

Providing help unobtrusively or indirectly is using mediation. The setting, described by Polya, is one in which the teacher is empowered with the *tool*. However, the setting created initially by Mrs. Scott was one in which the students were empowered with the *tools* while she was being empowered herself. Thus, students were allowed to take charge of their own learning as the control of the teaching and learning situation shifted from the teacher to the students. By creating a trusting atmosphere for the alternate approach in her class, Mrs. Scott embraced teamwork that transcended the borders of the isolated classrooms. She gave students an opportunity to voice their thoughts as they occurred, so the meaning they intended could emerge (**Finding # 23**).

As Mrs. Scott stated, *"direct teaching was not totally dead,"* but they sought creative means to employ it in unique ways. As a result of employing direct teaching in a creative way *Reciprocal Mathematics Teaching* (RMT) as an alternative approach to *Mediated Discovery* was generated. In this approach, the class-teacher employed direct teaching. Students within their groups reciprocated by employing direct teaching of the same concept(s), while other group members questioned the group-teachers who were providing the explanations (**Finding # 24**).

Mrs. Scott seemed to experiment with all aspects of her PDP experiences that were meaningful to her. She experimented with random grouping and other group sizes. Random grouping with group sizes of three gave students the opportunity to choose for their working-groups friends with whom they felt comfortable to work. Larger group sizes did not engender the same level of caring and maximum participation because students were grouped with those with whom they were not familiar. They were not as open and concerned about one another, weaknesses were unnoticed, and they did not think as a group (**Finding # 29**). Mrs. Scott experimented with the mediatory mode of teaching with a focus on empowering her students with this mode for learning, thus modifying their cognitive structures (Feuerstein & Feuerstein, 1991). Mrs. Scott's experimentation served to inform and encourage the other teachers' employment of the *tools* in their classes.

Embarking on a personal and individual translation of her PDP experiences in the classroom, Mrs. Sinclair started to initiate her students to grouping and to utilize the non-judgmental verbal and non-verbal responses by giving voice and listening to her students more to help them generate respect for one another's ideas and create a relaxed setting to allow students to think and clarify their thoughts (**Finding # 33**). Utilizing the *Mediated*

Discovery Approach in the student small-group setting, Mrs. Sinclair served only as facilitator. With all students participating, they drew from their mathematical skills and used their previous mathematical knowledge to arrive at the various solution paths to problems (**Finding # 39**).The setting for the *Mediated Discovery Approach* with the small-group context created a new social and mental environment for learning. Mrs. Sinclair's students felt good about themselves and were willing to explore, discover, and investigate solution paths to mathematics problems (**Finding # 40**). Embarking on the translation of his PDP experiences, which he claimed had raised his consciousness and made him aware as to how to put things in place for the teaching and learning context, Mr. Lennox began to employ nonjudgmental verbal and non-verbal *tools* for effective teaching and learning. As a result, students' responses were positive and students were not afraid to try to solve mathematics problems (**Finding # 41).**

All three teachers started the translation of their PDP experiences in the classroom by generating a trusting atmosphere in their classes. As with their experiences in the seminars, trust had to be established between and among the group members first. Each teacher's translation was different and unique.

Teachers' Overviews of Their Experiences of the MLP

Embarking on the *mathematics learning experiences,* teachers were at first hesitant. They thought it was time-consuming and were also hesitant to relinquish their responsibility of "pouring information into the mugs" and release their students to think for themselves (**Finding # 56)**. From teachers' past experiences and what they were told about grouping and leading students to "uncover" concepts for themselves, they thought it would be time consuming. However, after taking on the approach, teachers' perceptions changed with regard to the flexibility of the approach within the time-frame of the class period, the change in students' behaviors, the kind of learning that was taking place, and the time and effort teachers had to make to accommodate the approach (**Finding # 57**).

Embracing the principles embedded in the Mathematics Learning Program (MLP), teachers experienced difficulty in "being deprogrammed." They were now changed individuals, not just in terms of mathematics teaching but in terms of the general principles involved in teaching and learning. Each teacher became more versatile in his or her approach to the classroom teaching and learning experiences (**Finding # 63**). **Finding # 63** supports Vygotsky's (1981a) concept of internalization. The principles which had been mediated to teachers they now used to regulate their own behaviors by mediating these to their students. The principles had now become an internalized and personalized way of life. These internalized principles and techniques were difficult to be "flushed" from their experiences even with conscious effort. The internalized techniques and principles may be tailored for any and all occasions which make demands for such because they have been personalized. Teachers' cognitive structures were modified (Feuerstein & Feuerstein, 1991) by their experiences. This process serves to reinforce Vygotsky's (1978) premise that what an individual can do today in collaboration with others, he or she will be able to do by himself or herself tomorrow. Hence, the *Coaching Approach* as an alternate approach to teaching and learning employed the process of mediation to generate interactive discourses in a social context to bring about learning through experiencing.

Conclusion

Creating the Climate for the Professional Development Process

The principal's support was essential and appeared to be related to the level of importance that teachers attached to the professional development program. Without the principal and his administration's support, the program would probably have been a failure. Other regular activities would have been deemed more important than the activities of the program. Lack of support would have meant disruption because the administration would have been assigning teachers other duties and making other demands of them while they were involved in different aspects of the program.

The principal's interest in the program also triggered teachers' interests to experiment with ideas. If teachers had not been given release time from school activities, they probably would have deemed the program a burden and would have chosen not to participate. To avoid doubt, suspicion, and even sabotage; to encourage understanding and appreciation of an innovation; and to get an educational organization to operate as a "family"— a community with one major goal to enhance student learning—it is necessary to have members at the various levels of the hierarchy generate an interest in the particular innovation or program to be accommodated.

The Coaching Approach: An Alternate Approach for Teaching and Learning

If we do not profess to "know it all," then we might be able to generate and gain an experience that leads to learning through understanding. Engaging in collaboration (social interaction), learners set the pace for the development of their potential in the learning context as they generated and engaged in discourses. Because of the layers of discourses and the levels of discourse communities involved in the process, the conclusions learners drew were not considered to be wrong conclusions. Ideas, discoveries, and ways of interpreting and viewing concepts were always shared with the larger learning communities. These sharing opportunities provided verification, correction, elaboration, and other ways of viewing the same issues. Thus, learners gained new insights, perspectives, and content knowledge which had not been perceived before. They constructed, from their experiences, what was to be learned, and this in turn was enhanced by the sharing within the larger learning communities.

The *Coaching Approach* appears to subsume the constructivist paradigm that views learning as the harmonious functioning of both the psychological and the sociological perspectives and has it roots in Piaget's and von Glaserfeld's psychological theories that emphasize cognitive conflict, reflective abstraction, and conceptual reorganization for individual learning of mathematics (Wood, Cobb, & Yackel, 1991). The psychological perspective emphasizes that learners are active constructors of their own knowledge, while the sociological perspective emphasizes that learners become acculturated members of a community. Wood et al. maintained that, during the process involved in social interactions, the "common meanings or taken-as-shared knowledge of the wider society" (p. 560) are generated because of the process of negotiation of meaning that results from the explanations and justifications offered. Hence, "mathematical learning involves both personal construction of meaning and the negotiation of the taken-as-shared meaning of the community" as learners "are considered to be active reorganizers of their mathematical experiences" (Wood et al. p.561). Constructivism, Betts (1991) maintained "is both a set of assumptions (philosophical constructivism) and a set of behaviors consistent with them (pedagogical constructivism)" (p. 37).

A summary of the underlying assumptions as set forth by Clements and Battista (as cited in Wood et al., 1991) includes the following:

> - Knowledge is actively created by children and is not passively received from the environment (Paiget, 1989; von Glaserfeld, 1987).
> - Children create new mathematical knowledge by reflecting on their physical and mental actions (Piaget, 1970). In addition, children's actions are viewed as rational to them and reflect their current understanding (Labinowiz, 1985).
> - Substantive learning occurs in periods of conflict and confusion (Confrey, 1985), surprise (Lawler, 1981), and over long periods of time (Inhelder, Sinclair, & Bovet, 1974).
> - Learning is a social process in which children grow into a community (Bruner, 1990).
> - Mathematical ideas are cooperatively established by the members of a culture (Blumer, 1969; Bruner, 1986).
> - Opportunities for learning occur during social interaction involving collaborative dialogue (Barnes & Todd, 1977), explanation and justification (Cobb, in press) and negotiation of meaning (Voigt, 1985). (Wood et al., p. 591)

Most of these principles are both advocated by the constructivist paradigm and embraced by the *Coaching Approach*. My deduction that the *Coaching Approach* subsumes the constructivist paradigm supports Costa and Garmston's (1994) claim that "the coaching process incorporates the basic principles of knowledge construction by Jerome Bruner, Jean Piaget, and Hilda Taba" (p. 3). The principles embedded in the *Coaching Approach* are predicated on trust, a non-judgmental climate, and collegiality within the various levels of each community because they create "a safe atmosphere where learning and change can occur" (p. 3). These principles in the *Coaching Approach* are brought about through mediation (Feuerstein & Feuerstein, 1991) as employed by the vehicle of cognitive coaching (Costa & Garmston, 1994) for teachers' professional development, and by the questioning technique that provokes inquiry for the mathematics learning experiences in the classroom. The employment and end result of these principles do not, as is advocated by the constructivist paradigm, happen "over long periods of time." Instead, they take place as learners make meaning of their experiences as the spirit of inquiry is not arrested or paralyzed but is "awakened" as ideas are explored in the collaborative setting of a naturally occurring classroom. Also, in the *Coaching Approach* as well as in the constructivist paradigm, as learners engage in the learning of mathematics, it is not a learning experience that involves just computational and procedural knowledge but one in which intuition and principled knowledge are employed leading to conceptual understanding. It is not a learning experience in which learners receive knowledge passively but one in which knowledge is "actively constructed by the learners on a base of prior knowledge, attitudes, and values" (Betts, 1991, p. 37). The new dimensions in knowledge, according to Betts, "are developed from and shaped by personal experiences and the social cultural environment" because "what students learn is heavily dependent on the understanding they bring to the task" (p. 37). Hence, the *Coaching Approach* subsumes the constructivist view as emphasis is also placed on the foundation for trust and the *tools* of the *Coaching Approach* that lead to the generation of the learning experiences.

Eliminating Isolation and Generating Collaboration

Developing, establishing, and sustaining/maintaining trust is fundamental to any collaborative relationship. Through the generation of trust, one is allowed to examine one's own behaviors and that of others for the enhancement of learning and professional growth. Trust sets the pace for exploration and generates the setting where each one has a voice and where each person's ideas are valued. Respect for person-hood is the hallmark of this setting, the setting in which each person re-constructs that which is to be learned, internalized, and personalized.

Only when we trust will we allow others "psychological entrance" into "our world," our world of uncertainties, our world of "I don't know how; I don't understand; show me." Allowing someone this entry means: "I trust you; you will not ridicule me; you will not put me down; you will not make me feel dumb." Allowing this entry does not mean it is one directional. It is not a "superior" dealing with an "inferior"—not an "expert" dealing with a "novice." It is a two-way horizontal relationship; the feelings are reciprocated. It is collaboration and interdependence. The learner is free to explore and venture on a path that might not take him or her to a predetermined destination. Therefore, with trust comes the ability to take risks in the classroom both on the teacher-level as well as on the student-level. As a result, the freedom to express one's ideas without any feeling of intimidation leads to an extension of each persons' knowledge of or about the particular concept that is being explored. In my study, no intimidation by verbal or non-verbal messages was conveyed during the use of the trust building *tools*, so the *Coaching Approach* lent itself to a comfortable trust-building situation.

Discourses served as the means by which mediation, gaining attention, and developing thoughts and ideas took place:

> The means used to mediate social interaction are the same means used to mediate the cognitive processes of the individual as an independent cognitive agent. This adds to the coherence of . . . [this] approach. Cognitive processes in individuals do not somehow magically emerge out of the social interactions: rather, by coming to master the mediational means of social interaction, the child [/learner] masters the very means needed for independent cognitive processing. (Vygotsky, 1981b, p. 190, 191).

The important role played by the mediational process of the *tools* for *Coaching Discourses* utilized in the *Coaching Approach* is not only significant for the enhancement of social interaction in a collaborative context but also for cognitive mediation and metacognitive mediation. Hence, the *Coaching Approach* is a universal one for any community of learners in any culture and in any learning context.

Recommendations

1. That all stakeholders involved in the educational hierarchy be made aware of planned professional development programs for teachers and that the stakeholders be encouraged to participate and help create the culture for the development of the program.
2. That the *Coaching Approach* as an alternate approach for teaching and learning be embraced by students and teachers to optimize learning as a result of experiencing while both groups are actively engaged through the employment of the *tools* for

Coaching Discourses and the accommodation of the levels of the discourse communities in the regular everyday classroom learning context.

3. That the generation and development of trust be the fundamental platform/premise on which the *Coaching Approach* must be established to eliminate isolation and generate collaboration through the vehicle of *cognitive coaching* for administrators and in-service and pre-service teachers.
4. That the mechanism for mediation—the *tools* of *Coaching Discourses*—inherent in the *Coaching Approach* be embraced as the process by which collaborative learning incorporating social interaction is generated, the process by which attention and engagement are obtained, and the process by which cognitive and metacognitive mediation are triggered to generate learning by experience in the teaching and learning context of the everyday classroom for all pedagogical content knowledge areas including the *mathematics learning experiences* and for professional development including clinical supervision.
5. That the *tools* of the *Coaching Approach* be embraced as an integral part of the curriculum of teaching training programs as well as that of elementary, middle, and high schools.
6. That administrators encourage teachers in their school to collaborate not only with teachers of the same subject within their schools but with teachers of the same subject across schools.

Re-examining The Concept—Autopoiesis

In the old school of thought, it was perceived that something was understood when it is stored in memory and could be regurgitated upon demand—especially in the form in which it was given. But according to Dewey (1933), "nothing is really known except in so far as it is understood" (p. 148), and nothing is really understood unless it is experienced. This idea is summed up in the aphorism put forth by Maturana and Varela (1998) that "all doing is knowing and all knowing is doing" (p.26). Hence, the application of the idea was generated to bring forth a different approach to teaching and learning. It was perceived that for the generation of this idea, teachers had to experience for themselves what they needed their students to experience in the everyday classroom context. Consequently, as the experiences were set up, each teacher tried to apply every new experience to aid in understanding. Through these processes, the idea took on shape, "body, steadiness, distinction; it became a concept" (Dewey, 1933, p. 156). Thus, the concept of the autopoietic activity was inferred for the explanatory qualitative methodology as a research tool employed in the everyday teaching and learning context. According to Dewey,

> Suggested inferences are tested in thought to see whether different elements in the suggestion are coherent with one another. They are also tested, after one has been adopted, by action to see whether the consequences that are anticipated in thought occur in fact. (Dewey, 1933, p. 97)

The First Stage of My Thinking Process

The suggested inference was that PDP utilizing the vehicle of *cognitive coaching* would be of a fluid nature and would generate a high level of interaction among teachers. This would be reciprocated among the students and that which was generated among the students would in turn reciprocally influence the teachers' *professional development process* (PDP). Thus, PDP would be parallel to the students' *mathematics learning experiences* (MLP). This perceived conceptual framework is depicted in Chapter Two.

*PDP parallel to MLE and *PDP reciprocal to MLE

Hence, "testing in thought for consistency involves acting in imagination" (Dewey, 1933, p. 98). This perceived concept was tested mentally prior to the enactment of this study as I was invited by a member of my examination committee to project my thoughts and share my perceptions of what the situation would be like for both teachers and students. It was then carried out overtly during the actual study because "true inference is defined first as involving a leap to a suggested conclusion, and second as trying the suggestion to determine its agreement with the requirement of the situation"(p. 98). As a result, the "consequences of overt action "confirm, modify, or refute the idea" (Dewey, p. 105).

The Second Stage of My Thinking Process

Looking back on the enacted experience before I entered the analysis stage, I asked myself: "What did I really do?" This question generated thinking—an analysis in my mind—a re-enactment of the first phase of thinking. I concluded that I had done more than mere *cognitive coaching*. But if I had not, then what had I actually done? Reflecting on and assessing the processes involved in the total experience of the study, after much turmoil in my thoughts for about two weeks, it came like a bombshell!—*Coaching Discourses*!

1. Fitting the suggested conception into Maturana and Varela's (1998) proposition for providing an *explanatory qualitative methodology* for the research carried out by this study, I saw how the formal introduction of the trust building *tools* to the teachers was through *cognitive coaching*. This satisfied condition 2. So the generation of *Coaching Discourses* was a formal position.
2. We did not introduce the students formally to the *tools;* their use of the *tools* was an informal use which satisfied the informal condition—condition 3—the generation of the *mathematics learning experiences* (MLE).
3. Also, another informal condition—condition 3—was the reflections generated after the generation of *Coaching Discourses* during the seminars to further generate *Reflective Coaching Discourses.*
4. Another informal condition—condition 3—was the teachers' informal use of the *tools* during the summer holidays.

Like a child developing the concept of an animal, I was led to discriminate the particular qualities that characterized this entity even when dealing with similar entities for example, *Coaching Discourses* and *Reflective Coaching Discourses.* With *Coaching Discourse* as a standardized point of reference and according to the stage of my experience, I became aware of differences, and as a result of these processes the idea gained body, steadiness, and distinction and became a concept (Dewey, 1933)—a living self-reproducing thing, something that pulls itself up by its own bootstraps (Maturana & Verela, 1998)—the autopoietic activity—the inferred conception. Through these same processes the vague, formless idea acquired generality as the meaning was defined as well as extended while it was applied to comprehend new cases (Dewey, 1933)—PDP employing *Coaching Approach* reproduced MLE which employed the *Mediated Discovery Approach.*

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APPENDICES

APPENDIX A

Teacher Interviews Prior to PDP

Demographic Questions:

1. Male/female?
2. What is your level of education?
3. What teaching experience do you have? What subject have you taught?
4. What extra curricular activities are you involved in?

Essential Questions:

4. How do you view your role in the classroom?
5. What happens in a typical class? Can you describe?
6. What type of staff development activities do you engage in?
7. What provisions are made by the school for staff development activities?
8. How often do you participate in these activities?
9. Who generally conducts these staff development activities?
10. What is the nature of these staff development activities?
11. What type of informal activities do you engage in order to enhance your professional growth?
12. When do you general have your staff development activities?
13. How do you find yourself responding to these activities? Do you shy away or do you welcome the opportunity ?
14. How often do you engage in the planned staff development activities?
15. Have you ever initiated any of these staff development activities? If so could you describe such?

Surveying Teachers to ensure that program is aligned to their needs.

16. As you evaluate your own teaching day by day, are there any areas that you feel might be need some improvement in? If so, could you say more about this observation?
17. What ways have you thought of that might satisfy this lack? (If there is a lack). If teachers say there is no lack then question would be:

17b. For each school-term do you have all students doing exceptionally well in all of your math classes? If not, what ways could you employ that could bring about a change towards this end?

18. How about working with other colleagues (teachers) and sharing ideas, input and suggestions?
19. Have you ever tried this? Do you think it can work? Why or why not?
20. How do you feel about having an individual sit through your class and observe your teaching?
21. Have you ever had any feedback? What kind of feedback have these individuals provided you with (if any)?
22. To what extent does the feedback impacted on your teaching?

APPENDIX B

Letter to Principals
and
School Boards' Responses

Date

Department of Elementary Education
Faculty of Education
551 Education building South
University of Alberta
Edmonton
Canada T6G 2G5

Principal:
Address:

Dear ***Last Name:***

I hope you have received my fax expressing my appreciation to you and your Board for granting me the permission to conduct my research at your school. In my letter, I mentioned my not being able to begin January 1997 as I had originally planned, because there have been a few changes in the overall plan of my study due to the elaborations made.

My new date to begin my data collection will be September 1997. It will continue for two school terms as stated previously—September to March. Initially, I had requested that I work with at least one teacher, but it has elaborated somewhat and so I would be grateful if an administrator and as many teachers as possible from the mathematics department of your school could participate, particularly, at least one teacher who will be teaching Grade 10 and one who will be teaching Grade 11.

My study still involves the teaching and learning of certain techniques which can be easily accommodated in the regular day to day activities of the normal mathematics classroom. But it now involves a high level of reciprocity between teachers and students and students and students. It will also involve teachers working with other teachers within each school and if possible between the schools on this project.

I am still interested in Grade 10 students' (fourth formers') use of these techniques, but I would also like to focus on the Grade 11 students' (fifth formers') use as well. It would be good if all teachers in the mathematics department of your school could be involved even though my interest at this stage would be particularly with the Grades

10 and 11 students (fourth and fifth formers). I am aware of the fact that the daily tasks of the principal and vice principal demand much of his or her time and energy, but for the successful accommodation of this innovation, the involvement of the administration is key. My overall intent is to empower teachers so that when I, as researcher, am out of the situation the techniques will become a way of life for the teachers and students.

For the accommodation, I will have to conduct a series of seminars possibly for five days. I don't know your plans for staff development for the summer but I am hoping that this could be adopted for such. One other high school will be involved in this project, and I am hoping that both principals and mathematics teachers will be involved in the seminars together.

My plan for accommodation is for the first two terms of the school year 1997-1998 (September - March). In term one, teachers will work with each other learning and adapting the techniques to their particular situation while students will be learning and applying them in their mathematics classes. It is expected that by term two, students and teachers will become proficient in the employment of these techniques. By the end of term two, schools will be on their own, and administrators and teachers will continue to work together, going into term three and noting the impact on students' overall improvement in mathematics. The impact on students' performance is expected to be significant so that the Grade 10 students (Fourth Formers) coming up into Grade 11 (fifth form) will continue utilizing the techniques and the ripple effect will continue as administrators and teachers note the difference in performance at the CXC level with the various groups of students.

I trust that you and your staff will give this idea serious consideration. I look forward to a prompt and positive response.

Sincerely yours,

Enid F. McLymont (Mrs.)
Ph.D. Candidate

Diocese Of Jamaica

TELEPHONES
ADMINISTRATIVE OFFICE
BURSAR'S OFFICE
PRINCIPAL'S OFFICE

JAMAICA, WEST INDIES

November 5, 1996

Mrs. Enid F. McLymont,
3B- 8918 - 112 St.,
Edmonton Alberta
T6G2C5 Canada
Fax# 403-492-0390

Dear Mrs. McLymont,

On behalf of the Chairman and the Board of Governors I should like to thank you for the interest shown in conducting a part of your research at

Our discussions a few months ago convinced me that your proposed study could prove mutually beneficial.

Consequently I should like to inform you that the Chairman as well as the entire school family, looks forward to having you in January 1997.

In the mean time I should like to express to you our best wishes as you continue your studies at the University of Alberta.

On a personal note kindly give my regards to Dr. George Cathcart and his wife Gloria.

Sincerely yours,

....

(Mr)
Principal

Jamaica. W.I.
Telephone.
Cable Address.

December 18, 1996

Mrs. Enid F. McLymont
3B-8918 - 112 Street,
Edmonton, Alberta
Canada T6G 2C5

Dear Mrs. McLymont

The High School Executive Board at its meeting held on December 12, 1996, voted to grant you permission to conduct your doctorial research at the High School, commencing January 1997.

We wish you well in your research and know that the Lord will guide you to the end.

Respectfully

APPENDIX C

Open-ended Questions For All Teachers
At the End of PDP Seminars—September 22 PDP

Questions at End of the PDP Seminars—September 22 PDP
(Journaling or Interview)

1. How did you feel about the series of seminars?
2. What have you gained from the seminar experiences?
3. What have you learned about cognitive coaching?
4. What new dimension has been added to your idea on teaching?
5. What else have you gained from the experience?
6. How has this experience affected your behavior? (e.g., teaching, communication, etc.)
7. To what extent will you use this in the classroom?
8. How does your translation of this experience influence your students in the classroom?
9. Would you like to continue in this project?

APPENDIX D

Questions for Semi-Structured Group Interview Session
(October 22)

Semi-Structured Interview

October 22, 1997

1. What I would like to know is: what do you like or do not like about this experience? What is working, and what is not working? Anybody can begin.
2. Have you recognized anything about yourself that you could term a strength or a weakness?
3. During the coaching experience did you make a difference to your partners' coaching experience and if so, how? Experiencing the coaching does it make a difference to how you coach?
4. Envision yourself in the classroom situation after having gone through this experience what you are accomplishing in your class now that you might not have achieved on your own?
5. Initially, did you believe that you could have made a difference to the teaching and learning situation? That is, when you started in September.
6. How were you able to come up with alternative strategies?

APPENDIX E

Questions For Students' Reflective Paragraph Writing

Questions For Students' Reflective Paragraph Writing

1. What did you like or did not like about your group activity?
2. What did you recognize (discover) about yourself that you could term a strength or a limitation?

Efficacy:

3. Did you make a difference in your group toward the solution of the given problems?
4. How were you able to make such a difference?
5. Did you believe initially that you could have made a difference?

Flexibility:

6. Were you able to develop alternatives for the solution of problems?
7. How did you treat the alternatives suggested by the others in your group?

Craftsmanship:

8. What sort of activities did you pursue to perfect your skills in solving the particular problems?
9. How did your solutions to and explanations of problems show that you are constructing deeper and broader understanding of mathematics concepts?
10. Do you provide or explore more than one solutions or more than one approaches to problems? Explain.

Interdependence:

11. How did the group lead to your success in understanding the concepts involved in this lesson?
12. How do you resolve the difficulties you face with certain questions/problems?
13. What do you notice about yourself in relating to the others in your group? Are you listening more? Are you volunteering information more?

Consciousness:

14. How did thinking about the questions used in the group interaction affect your performance?
15. What did you find easy about the group activities, what did you find difficult?

APPENDIX F

Letter of Invitation to Teachers

Date:

Department of Elementary Education
Faculty of Education
551 Education Building South
University of Alberta
Edmonton
Canada T6G 2G5

Dear ***"Last Name,"***

I am a graduate student in the Department of Elementary Education at the University of Alberta. I have been awarded a Canadian International Development Agency (CIDA) Scholarship as part of a joint project between CIDA and the Joint Board of Teacher Education at the University of the West Indies (UWI), for the development and improvement of teacher education in Jamaica (pre-service and in-service). This scholarship affords me the privilege of reading for a Ph.D. in Mathematics Education.

My concern for the national pass rate in the exiting external examination (CXC) averaging below 25% each year, led me to the development of this project utilizing the vehicle of Cognitive Coaching for the teaching and learning of mathematics. It is expected that this approach to teaching will impact greatly on students' performance in mathematics. Therefore, as part of my doctoral dissertation research, I will be investigating the use of Cognitive Coaching by teachers and students during the different stages of a project. The stages deal with a Professional Development Process (PDP) and a Mathematics Learning Process (MLP). The professional development Process (PDP) will include a five-day seminar series, monthly professional development sessions, and coaching conferences, while the **Mathematics Learning Process (MLP)** dealing with students' learning experiences will last for one school term.

The major purpose of utilizing Cognitive Coaching will be to enhance communication skills, rapport, trust, the states of mind, and improvement in mathematical performance of all students involved.

I am requesting your participation in the PDP as well as in the **MLP**. The fact that coaching involves at least two persons, I would like you to choose another teacher from the math department with whom you would like to coalesce. I would also like you to choose one of your mathematics classes that you would like to use the techniques with.

During the five-day seminar series you will develop the skills involved in Cognitive Coaching. The fact that all mathematics teachers from two schools will be involved in the PDP, it will necessitate one set of teachers to commute to the site where the seminar will be held. Financial assistance for transportation will be provided for those who will have to commute. Lunch will be provided for all teachers involved in the seminars.

Should you consent to participate, I would like you and your coaching partner to record one coaching cycle each month for one of your mathematics classes. Each coaching cycle should last at least 20 - 30 minutes. I would also like to interview you once during the term and at the end of the term concerning your reflections, insights, and suggestions on the coaching experience, and also your ideas on its use in one of your mathematics classes. Each interview session should last for half an hour. I will audio tape each interview to ensure accuracy and authenticity of information.

For the class which will be chosen to use the coaching techniques in the learning of mathematics, I would like to audio-tape a sample of the group discourses during the mathematics classes. With your help, I will also like students to write a paragraph guided by specific questions through out the period of study, to gain their reflections and insights about their group experience and how it is influencing their mathematics performance.

I must hasten to reassure you, however, that, in adherence to the Code of Ethics as stipulated by the University of Alberta, I will be using pseudonyms for all participants involved in this study to ensure anonymity and confidentiality of information.

If you are willing to participate in this study, please complete the attached consent form and return it to me using the enclosed self-addressed envelope. I will be in Jamaica early June to visit with you and answer any questions you may have related to this study. You may contact me at 962 - 2204-7.

Your participation in this study is very important to the development of alternative ways of teaching mathematics geared at the improvement of mathematics performance at the high school level in Jamaica.

I look forward to your positive response of agreeing to participate in this study by sharing your time and your insights. I hope the process will be one that you will find invaluable for your personal professional development as well as your teaching experience in the mathematics classroom.

Sincerely,

Enid F. McLymont
Ph.D. Candidate

Consent Form for Teachers' Participation

I, __________________ acknowledge that **I DO Consent** to participate in tape recorded interviews and coaching sessions as part of the research requirements at the University of Alberta, as described in the letter of request from Enid McLymont.

Signed: -- Date:______________________________

OR

I ______________________________acknowledge that **I Do NOT Consent** to participate in tape recorded interviews and coaching sessions as part of the research requirements at the University of Alberta, as described in the letter of request from Enid McLymont.

Signed: -- Date:______________________________

APPENDIX G

A Mediated Discovery Lesson Planning Conference Session
Mr. Lennox Coaching Mrs. Scott

Thursday December 4, 1997 for class Friday Dec. 5, 1997

Mr. Lennox: Pleasant Good morning to you. It is a great pleasure for the very first time to be coaching you, Mrs. Scott. My very first question is what is your topic?

Mrs. Scott: The class is 4 Sc. and the topic is solving pairs of simultaneous equations.

Mr. Lennox: Solving pairs of simultaneous equations. What are your objectives for this lesson?

Mrs. Scott: I have one objective in particular. Students should be able to solve linear simultaneous equations by the method of elimination.

Mr. Lennox: By elimination, just elimination?

Mrs. Scott: Just elimination.

Mr. Lennox: How do you plan to achieve this objective?

Mrs. Scott: Students, they are in groups of 3's and they will be given specific equations to investigate. The investigation will entail direct instruction to add or to subtract the two equations . . . and state their observations. If they add or if they subtract what happens? They will be stating their observations and from the observations they will be asked to make assumptions. And then they will be testing the assumptions that they make in other equations.

Mr. Lennox: Other equations meaning previous or what they would have done.

Mrs. Scott: They will be using some for the investigations and from that they will draw conclusions. Then they will test these assumptions on other equations. To find out if the assumptions that they make will hold for other equations.

Mr. Lennox: What are some of the assumptions that you are hoping that they will come up with?

Mrs. Scott: Well, I am hoping that they will come up with the reasons a particular variable is eliminated either when you add or when you subtract and under what conditions this happens. The conditions will be based on the observations that they have made, and from that they make the assumptions either that the sign will be different for them to add or the coefficient or the variable would have to be the same . . . things like that. And then they would have to test these assumptions that they are making with other equations to find out if they stand true.

Mr. Lennox: Those "other equations," would you be giving them?

Mrs. Scott: No, they will just select them from their text. They will select them to test them to see if their assumptions are true. Each group at the end will disclose to the whole-group what their findings were: What were their observations? What were the assumptions that they made? What did they test? and does it hold true? They are not solving the entire equations to find the values as yet, just the elimination of one or both of the variables and under what conditions were they able to eliminate any of the variables?

Mr. Lennox: So you are saying that they are going to be placed in groups of three's to carry out all of this process. How large is the entire class?

Mrs. Scott: The entire class is 25 students.

Mr. Lennox: So eight groups. What is your time frame for that class?

Mrs. Scott: A double session.

Mr. Lennox: It's a double session? For tomorrow?

Mrs. Scott: Yes.

Mr. Lennox: Ok. So after they have come up with the assumptions and shared their information with their large group, what do you plan to do next?

Mrs. Scott: Ok. I am expecting from the responses that the assumptions will be what I am expecting—they will be correct. However, their disclosing what they have observed will give us a chance to see whether the assumptions are correct, and if they are not correct what we will do is to ask them to test it on a particular equation; one that it would not hold true for. For example, a child might say . . . when we have two positive signs we subtract, and then I might put two negatives for it to be tested in that so that the child might have a chance to reassess his or her own evaluation of the whole thing. Now I have two negative signs they will state in the conclusion that when I have two positive signs then I add, subtract, or whatever. So I would give two negative signs to test.

Mr. Lennox: Ok to test what they would have done.

Mrs. Scott: So they will be given the chance to go over the assumptions to identify whether they are correct or incorrect. To begin, I would not tell them whether they are right or whether they are wrong. I would just give them things to test. Because whatever they say is correct I would ask them to test it in another equation or equations.

Mr. Lennox: Ok. At this point, I am allowed to ask questions. Have you thought of another way you could have them making these assumptions?

Mr. Scott: Yes. I have thought of other ways. This is not the first time that they have started the solution to simultaneous equations. They have started before by simply giving them equations for them to solve. They did it by trial and error fairly well. They did it by substitution without any help. The problem is that nobody is coming up with the elimination adequately. One group that tried it came up it in the horizontal mode. By equating it to zero and eliminating on both sides, it was out of that and out of someone in the class having previous knowledge about adding and subtracting … it was out of this that this method came about as a result of what was happening in the class … so this came out of what we were doing.

Mr. Lennox: They will appreciate it more too in that sense that it is something coming from them and seeing it progressing. Ok. You have two periods to do this class. Have you thought of the time frame that they will to spend on doing the first three problems.

Mrs. Scott: I would say the first 30 minutes for the investigation because it is a continuation so that is for the first session of the class, and therefore we have the entire second session—thirty minutes—for the reporting, discussion, and drawing the conclusions. Because I want the conclusions to be made before the next class so we can be move on to solving. So I want to spend the second session of the class getting the conclusions

Mr. Lennox: Ok and maybe filling in the missing links.

Mrs. Scott: Yes, if there are any.

Mr. Lennox: Right. Very interesting, I can't help myself saying that, I know that that is a judgmental term, but the coaching process has really been trying to get us not to be saying that, but I am really looking forward to see the class going.

Mrs. Scott: May I ask though for you to make some specific observations for me on my timing, re my wait time especially when they are giving their report? My wait time, when I ask a question—the time I give for response—and if they ask a question am I demonstrating that time, "thought" time, by not responding immediately by giving the entire class enough time to think about it and what my response might be. Also, my paraphrasing I want to role play this that they can now get it in their own groups. So I want to be paraphrasing, and you can also look out for my questioning.

Mr. Lennox: Questioning?

Mrs. Scott: I am trying to develop a mastery of it so it can be translated in the class and so that they can adopt it in their own groups. Questioning, like for instance, instead of me asking them to write this, I make it as a suggestion rather than a command, so my questioning technique, and the clarity of my questions.

Mr. Lennox: So not just the technique but also the clarity.

Mrs. Scott: Yes.

Mr. Lennox. So you are saying then that you want me to observe wait time both the responses from the students and the time that you … whenever you ask them a question you want to know whether you are giving them sufficient time to answer and vice versa.

Mrs. Scott: Yes, if they ask me a question do I give enough time for them to think about what they just asked, or do I paraphrase to give them the opportunity to think about what they just asked. The clarification of the whole thing to think about it and maybe have a response ready in their mind so that when I give my response. . .they might be able to respond accordingly. Because I do think that I answer too quickly and I do not give them enough time to think about what they ask or even about what I could be answering.

Mr. Lennox: Ok. This question popped up in my mind . . . I noticed that the whole basis of the lesson is a kind of investigatory approach and ammm I did not ask you earlier if there is any exercise that perhaps that you might want them to take home or you mentioned that you are going to get the responses that you will be able to know what to do for the next class. But have you thought of maybe having them individually going off to maybe solve some problems using that method before they actually come back to class?

Mrs. Scott: Ammm I will probably give them an assignment, no, maybe what I could do that after they state what the conclusions is. Maybe we could take one of the problems and go through it because they already know substitution and whatever, so the rest of it would not have been a problem. But maybe this could be my part where I could just go through a problem in its entirety in a whole-group setting and then maybe I will let them assign their own practice problems.

Mr. Lennox: Ok. But what you really set up them to do is something good wherein actually since they have known how to solve by substitution already and with the discovery now ammm I think in all fairness it would have been very good to give them some to solve and to see if they could solve them instead of you actually going through a problem with them.

Mrs. Scott: Immm hmmm

Mr. Lennox: So that when they come back to class now you will see how they have done it and you could perhaps fill in the missing links.

Mrs. Scott: Into the class. Ok I'll take that suggestion.

Mr. Lennox: Because the whole idea is really an investigatory approach. I think this is really adding a lot to the whole learning … this is one of the things all along the line that I have been thinking about. Very good. So going back to your specific request, you want me to observe: wait-time, paraphrasing, how you ask your question. And you are hoping too that by your paraphrasing the students would be learning how in terms of maybe do the same like in their teacher-exercises when they are going to ask question in their groups.

Mrs. Scott: Sorry just to go back, ammm at the closure—the closing exercise—I would ask them to solve one problem in the class.

Mr. Lennox: Ok.

Mrs. Scott: They could check to see if they understand just in case, because what I have noticed is that some of them have been going through the problems entirely already but the substitution part they handle fairly well because they have done solution of quadratics already. . . .So it is the linear that is taking them much time, the problem was with the elimination. So we will probable try and fit this into the closure. They will be going home for the weekend so we will be using the closure to solve a particular problem.

Researcher: You could also extend it to have them solve the same problem by substitution and use it for checking.

Mr. Lennox: Ok, that sounds interesting. We have taken about 15 minutes to go through this pre-conferencing and I am looking forward to the class.

APPENDIX H

Sample of Students' Written Work

Mathematics
October 1, 1997
4 gen.

1. $6x^2 - 7x - 20 = 0$

$a = 6,\ b = -7,\ c = -20$ substitute the numbers in the fraction by letters.

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$ write the quadratic formula.

$$\frac{-7 \pm \sqrt{7^2 - 4(6)(-20)}}{2(6)}$$ substitute the letters in the formula in numerical form.

$$\frac{-7 \pm \sqrt{49 - 480}}{12}$$ ~~[illegible]~~

$$\frac{-7 \pm \sqrt{-431}}{12}$$ find the square root of -431

$$\frac{-7 \pm \sqrt{20.8}}{12}$$

After finding the square root you use the neg sign and positive sign to get your answer.

$$\frac{-7 + 20.8}{12} = \frac{13.8}{12} = 1.15$$

$$\frac{-7 - 20.8}{12} = \frac{-27.8}{12} = -2.3$$

(A 9 Oct 1 w r)

Harts
Mathematics

① Solve in elimination method

$5x + 3y = 27$
$2x + 5y = 26$

① Number the equations 1 and 2 so it may read:-

$5x + 3y = 27 \quad (1)$
$2x + 5y = 26 \quad (2)$

② multiply both equations by a number so the the numbers that are to be eliminated may be the same:-

$5x + 3y = 27 \quad (1) \times 5$
$\underline{2x + 5y = 26 \quad (2) \times 3}$

$25x + 15y = 135 \quad (3)$
$-6x + 15y = 78 \quad (\;)$

③ The above was equation 3 and 4 after being multiplied by 3 and 5

④ Substract both equation because when the signs are the same you would subtract.

$$\begin{array}{r} 25x + 15y = 134 \\ -\; 6x + 15y = 78 \\ \hline 19x + 0 = 54 \end{array}$$

⑤ divide both sides by 19 to get the value of x

$$\frac{\cancel{19}x}{\cancel{19}} + 0 = \frac{57}{19}$$

$$x = 3$$

⑥ The value for $x = 3$
use three for the place of x in equation 1 or 2 to get the value of y. Use equation 1

$$5x + 3y = 27$$

$$5(3) + 3y = 27$$
$$15 + 3y = 27$$
$$15 - 15 + 3y = 27 - 15$$

⑦ Subtract 15 from both sides because 15 was the answer when 3 was used for x.

$$3y = 27 - 15$$

$$3y = 12$$

⑧ divide both sides by three

$$\frac{\cancel{3}y}{\cancel{3}} = \frac{\cancel{12}4}{\cancel{3}}$$

$$y = 4$$

Therefore $x = 3$ and $y = 4$

Mathematics

4 Arts

4.12.97

Home Work.

Factorising when $A > 1$

$8x^2 + 10x + 3$

Step 1 - find the products of ac

$: 8 \times 3 = 24,$

Step 2 - When you multiply two numbers you get ac and when you add them you get b

$: 6 \times 4 = 24$ (ac)

$: 6 + 4 = 10$ ⓑ

Step 3 - factorise by grouping

$= 8x + 6x + 4x + 3$

$(8x + 6x) + (4x + 3)$ group

Step 4 - factorise

$: 2x(4x + 3)$

$: 1(4x + 3$

P.T.O

Step 5 - collect like terms

$(2x+1)\ (4x+3)$

Step 6: - Check answer

$(2x+1)\ (4x+3)$

Step 7 Remove brackets

(i) $2x * 4x = 8x^2$

(ii) $2x * 3 = 6x$

(iii) $1 \times 4x = 4x$

(iv) $1 \times 3 = 3$

$8x^2 + 6x + 4x + 3$

$8x^2 + 10x + 3$

Dec 1, 1997

Form A general
Explaination

(A 14 Declwr)

1. $6x^2 - 7x - 20 = 0$
Here the equation is already equated to zero.

2. find the values of $a, \overset{b}{\textcircled{B}}, c$ as seen in the formula. $a = 6$, $B = -7$, $c = -20$

3. It is best to write the formula for easier substitution

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

4. Carefully substitute the value of the letters in the equation with these value of these in the problem

$$x = \frac{-7 \pm \sqrt{-7^2 - 4 \cdot 6 \cdot -20}}{2 \cdot 6}$$

5. $x =$ Simplify by work out all the multiplication squares etc

$$\frac{-7 \pm \sqrt{49 + 480}}{12}$$

6. Add the two number ~~of~~ under the square root sign

$$-7 \pm \sqrt{\frac{529}{12}}$$

7 Find the square root of the Sur

$x=$ $x = -7 \pm \frac{23}{12}$

8 Separate the two value

$x = \frac{-7+23}{12}$ or $\frac{-7-23}{12}$

9. Then solve for the answer by:

i $\frac{-7+23}{12}$ adding the two number at the top and deviding by 12(bottom no)

$\frac{16}{12}$

$= 1.33$ OR

ii $\frac{-7-23}{12}$

$\frac{-30}{12}$

$= -2.5$

So the value of $x = -2.5$ or 1.33

2. $x^2 + 4x + 8$

First there needs to be four term. So derive another term which when you add multiply ~~by~~ the two numbers you get the middle term and when they are multiplied you get the last term

Form 4 Gen
Mathematics
4/12/97

Steps use to solve $8x^2+10x+3$ which
expression
is a quadritic equation.

Step 1:- Firstly find the product of AC which is $3 \times 8 = 24$

Step 2:- Secondly find two numbers that when added gives the sum of B which is 10 and when multiplied gives the product of AC which is 24.
The numbers are 6 and 4.

$$8x^2+4x+6x+3$$

Step 3:- Thirdly factorise the terms by grouping.

$$(8x^2+4x)+(6x+3)$$
$$4x(2x+1)+3(2x+1)$$

Step 4:- Forthly simplify the terms

$$4x(2x+1)+3(2x+1)$$
$$(4x+3)(2x+1)$$

form : 4 arts
Subject: Mathematics
December 4, 1994

① $8x^2 + 10x + 3$

step 1

The first thing to do is to find the product of AC = $8x$ (a) × 3 (c).

= 24

Step 2

find the two numbers when multiplied is equal to the product of 24

And when Added would be equal to = 10

∴ It would read

$8x^2 + 6x + 4x + 3$

The two numbers are 6 and 4

Step 3

Group the ~~equations~~ given terms

$(8x^2 + 6x) + (4x + 3)$

Step 4

Factorize the given terms.

$2x(4x + 3) + 1(4x + 3$

$= (2x + 1)(4x + 3)$

The Answer would be

$= (2x + 1) \cdot (4x + 3)$

To find if the Answer is correct or to prove the Answer you would multiply one bracket by the other.

$2x(4x + 3) + 1(4x + 3)$

$8x^2 + 6x + 4x + 3$

$= 8x^2 + 10x + 3$

Form 4 Generals
Subject Mathematics
Date : Nov. 13 1997.

① $5x + 3y = 27$ [1] x 5
$2x + 5y = 26$ [2] x 3

I multiply equation [1] by 5 to make the variables the same. By doing so my result is :

$$25x + 15y = 135$$

Then I multiply equation [2] by 3 to get the variables equal, my result is :

$$6x + 15y = 78$$

So therefore my third and fourth equation will be

$$25x + 15y = 135 \quad [3]$$
$$\underline{+\ 6x + 15y = 78} \quad [4]$$

Because the variables are equal, and the signs before them are the same I Substract. If the variables were not equal I would add to get zero.

$$\begin{array}{r} 25x + 15y = 135 \\ \underline{-\ \ 6x \quad 15y = 78} \\ \dfrac{19x}{19} \qquad = \dfrac{57}{19} \end{array}$$

$$x = 3$$

your result for $x = 3$
Then you substitute 3 where x is in any of the equation either

equation one or two.
Lets use equation one.

$5x + 3y = 27$
$5(3) + 3y = 27$
Substitute 3 where x is.
you now end up with an equation
$5 \times 3 + 3y = 27$
$15 + 3y = 27$

then you substract 15 from both sides to get $3y$ on one side.
$15 - 15 + 3y = 27 - 15$
$\frac{\cancel{3}y}{\cancel{3}} = \frac{\cancel{12}^{4}}{\cancel{3}}$
Then you divide by 3 because $3y$ means $3 \times y$ and you do the receprocal to get the value of y by dividing by 3.
your result for $y = 4$

Therefore $y = 4$, x is equal to 3.

you can check your answer by putting or substituting 4 for y and 3 for x

(eg) $5x + 3y = 27$
$5(3) + 3(4) = 27$
$15 + 12 = 27$
$27 = 27$
your equation is balance.

APPENDIX I

Letter of Request for Continued Use of MLP

Diocese Of Jamaica

TELEPHONES
ADMINISTRATIVE OFFICE
BURSAR'S OFFICE
FAX:

JAMAICA, WEST INDIES

January 4, 1999

Dear Mrs Enid F. McLymont,

Seasons greetings.

On behalf of the Mathematics Department, I am hereby requesting permission to use the **Maths Learning Programme (MLP)** in the present fourth form classes.

This request is being made as a result of the existing needs and concerns in this year group.

After evaluation and discussion with the teachers of department it was a consensus that the MLP be used. Thus enable us to address both the needs of students and the teachers. Also there was no foreseeable clash with the Reform of Secondary School Education (R.O.S.E.) programme at this level at this time.

We are hoping that you will consent because your programme has benefitted this department tremendously, not only has it fostered an excellent interpersonal relationship between the members of the department but it also enhances the teaching- learning process. We have found that our students learn more, they retain more, there is creativity and confidence in their approach to the subject. The entire fifth Form (121 students) will be sitting Mathematics at the General Proficiency level of the Caribbean Examination Council (C.X.C.) this year. This is a direct result of the MLP coupled with the confidence gained from last years' C.X.C. Mathematics results (this increased from 18% in 1997 to 53% in 1998).

We are desiring that this present set of fourth formers experience the MLP approach in its entirety, so they too may become 'efficacious' as you would put it. Also for our new teachers to become involved and be transformed by the process as we have been. Although we have tried to abort the approach in the lower school as agreed prior to your departure January 1998. It has been extremely difficult.

As I am sure you know that the MLP is not that easy to remove from one's system. Once you have been exposed to MLP, it becomes you.

Thanks for choosing as your pilot. Anticipating a favorable response.

Yours sincerely,

....

(Mrs)

H.O.D. Mathematics and Science

....

(Mr.)

Principal

APPENDIX J

About the Author

ENID F. MCLYMONT

Northern Caribbean University, Mandeville,
Manchester, Jamaica W.I.
mclymonte@yahoo.com

PROFESSIONAL OBJECTIVE

A position researching and teaching elementary and high-school mathematics education utilizing the tools of cognitive coaching for teacher collaboration and professional development at a University or college.

EDUCATION

September 2000	**Ph.D.** Faculty of Education, University of Alberta.
Summers 1994 & '95	University of the West Indies (UWI)/University of Alberta Institute at UWI (Science).
September 1990 - May 1992	**M.A. Curriculum and Instruction. Emphasis: Mathematics Education,** May, 1992. University of Connecticut, Storrs, Connecticut.
Summers 1988 & 1989	Part-time studies toward a Master's Degree in (Summers) Education. Andrews University Extension Center, Northern Caribbean University formerly West Indies College (WIC), Mandeville, Jamaica (20 Credits).
1984 - May, 1988	**B.Sc. Mathematics, minor in Education.** Northern Caribbean University formerly WIC, Mandeville, Manchester, Jamaica W.I.
Summer 1988	**Certificate.** Lay Bible Worker, Northern Caribbean University formerly WIC, Mandeville, Manchester, Jamaica W.I.
September 1975 - 1976 & 1977 - June 1979	**Teachers' Certificate.** Emphasis in Mathematics and General Science (Secondary Education). Mico Teachers College, Kingston, Jamaica, W.I. (Took one year's leave).

HONORS, ACHIEVEMENTS, AND AWARDS

April 1999	**University of Alberta Bursary**.
April 1998	Recipient of the **Graduate Student Travel Awards** to Conference, University of Alberta.
December 1997	Recipient of **Dissertation Grant**, Johann Jacobs Foundation, Zurich Switzerland.
April 1996	Recipient of **Mary Louise Imre Graduate Student Award** -- University of Alberta, Edmonton Canada.
August 1995	Recipient of **CIDA Scholarship** to read for Ph.D. -- University of Alberta.
August 1994	**Visiting Professor, University of Alberta.** Four-month Canadian International Development Agency **(CIDA) Scholarship**.
December 1989	Recipient of **Fulbright Scholarship** to read for Masters Degree.
Summers 1989 & 1990	Recipient of **World Bank Fellowship**. Mathematics Teachers' Workshop, Michigan State University.
March 1988	**Dean's List,** Northern Caribbean University formerly WIC.

GRADUATE APPOINTMENT

September 1998 - June 1999	**Research Assistant** to Dr. Joyce Bainbridge, University of Alberta.

CONFERENCE PRESENTATIONS

Feb. 25 - 26, 2000	**McLymont, E. F.** *Employing the Trust-building Tools of Cognitive Coaching Discourses for Effective Communication in Teaching and Learning*. Paper presented at the 3rd African Society Conference 2000: Prospects for an African Renaissance. University of Alberta, Edmonton, Canada.
July 4 - 9, 1999	**McLymont, E. F.** *Alternative Approaches to Teaching Mathematics Facilitated by Cognitive Coaching*. Paper presented at the 8th International Thinking Conference, Edmonton, Alberta, Canada.

Feb. 18-20, 1999

McLymont, E. F. *Employing the Genres of Reflective Coaching Discourses Through the Non- Judgmental Verbal and Non-verbal Strategies in Teaching and Learning.* Paper Presented at the First International Interdisciplinary Conference: Advances in Qualitative Methods. Edmonton, Alberta, Canada.

July 26 -
Aug. 1, 1998

McLymont, E. F. Facilitating Coaching Discourses to create the climate for Conceptual Understanding in Learning Mathematics. Paper Presented at the International Multicultural Conference. University of Alberta, Canada.

April 13 - 17, 1998

McLymont, E. F. & da Costa, J. L.. *Cognitive Coaching the Vehicle for Professional Development and Teacher Collaboration.* Paper Presented at the American Educational Research Association (AERA) Conference. San Diego, California, USA.

PUBLICATION

McLymont, E. (1998). Facilitating Coaching Discourses to create the climate for conceptual understanding in learning mathematics. In A. Richardson (Ed.), *International multiculturalism 1998 preparing together for the 21st Century* (pp. 236 - 250). Alberta, Canada: Kanata Learning Company.

McLymont, E. F. (1996). A "day" in the life of Oxy-O-Two: Storytelling as a teaching technique. *Alberta Science Education Journal: A publication of the science council of the Alberta teachers' association*, 29 (2), 4 - 6.

TEACHING AND RELATED EXPERIENCES

1980 - Present

Teacher of Mathematics and General Science at Northern Caribbean University formerly WIC with joint appointment in the Department of Mathematics and the Division of Teacher Education & Psychology.

- Taught mathematics and general science—content and methods at all levels.
- Designed and taught General mathematics course for students across disciplines.
- Taught pre-calculus to students across disciplines.
- Taught the course concepts of christian education—a foundation course—to students across disciplines.
- Conducted Freshman seminars.
- Taught Basic Math to students across disciplines

1980 - 1995	**Supervisor - Student Teachers**, Northern Caribbean University formerly WIC.
1993 - 1994	**Coordinator of Student Teacher Practicum**, Northern Caribbean University formerly WIC.
1992 - 1993	**Acting Director of Freshman Advisement**, Northern Caribbean University formerly WIC.
1979 - 1980	**Classroom Teacher.** Teacher of General Science and English at St. George's Boys College.

PROFESSIONAL ASSOCIATIONS

1999 - Present	**Member** of the Canadian Federation of University Women—affiliated with I.F.U.W.
1997 - Present	**Member** of American Educational Research Association (AERA).
1992 - Present	**Member** of National Council of Teachers of Mathematics (NCTM).
1995 - 1996	**Graduate Student Representative** to the Department of Elementary Education Council.
1992 - 1996	**Member** of Association for Supervision and Curriculum Development (ASCD).
1994 -1995	**Member** of the Self - Study Committee, Northern Caribbean University formerly WIC.
1993 - 1995	**Sponsor** of Honors Society, Northern Caribbean University formerly WIC.
1993 - 1995	**Member** of the Examinations Council, Northern Caribbean University formerly WIC.
1985 - 1995	**Co-ordinator & Sponsor** Teachers of Tomorrow Club, Northern Caribbean University formerly WIC.
1985 - 1995	**Member** of The Jamaica Association of Teacher Educators (JATE).

1983 - 1995	**Member** of The Jamaica Science Teachers' Association.
1980 - 1995	**Member** of The Mathematics Board of Studies; Also a member of the Science Board of Studies (For Teachers' Colleges).
1992-1994	**Chair**, Scholarship and Awards Committee, Northern Caribbean University formerly WIC.
March 1992	**Initiated as Member** of PHI DELTA KAPPA (Connecticut).
1986-1989	**Assistant Secretary** of Mathematics Board of Studies.

COMMUNITY ORGANIZATION

1975 - Present	**Sabbath School Teacher** (Cradle Roll to Adults).
1998 (Sept.)	**Co-ordinator** Edmonton Regional Prayer-The-Heartbeat Ministries
1993 - 1995	**Secretary** (Church Clerk) of Maranatha Seventh Day Church.
1993 -	**Member** of Manchester Drug Awareness Committee.
1989 - 1990	**Secretary** of Manchester Health & Welfare Community Services.
1986 - 1993	**Lay Activities Leader** (Assistant Church Elder --Maranatha SDA church).
1984 - 1990	**Treasurer**, Education Sponsor - Maranatha SDA Church.
1973 - 1978	**Volunteer Teacher** in JAMAL Program (Adult Literacy).

INTERESTS Gardening, sewing, floral arrangement, & reading,

REFERENCES References will be forwarded upon request

COURSE WORK COMPLETED

Research:

- Introduction to Educational Research
- Doctoral Seminar in Teacher Education
- Data Analysis
- Qualitative Research Methods in Education
- Research Methods II
- Research in Mathematics Education

Other Areas of Interest:

- Supervision of Educational Personnel
- Assessing Problem Solving and Student Beliefs
- Cognitive Styles and Strategies
- Writing and Publishing in Education
- Symposium in Elementary Education